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CHEMISTRY.—*Cyanogenesis and enzyme activity in sorghum varieties.*[1] JAMES F. COUCH and REINHOLD R. BRIESE, U. S. Bureau of Animal Industry.

Our knowledge of the decomposition of cyanogenetic glucosides by their appropriate enzymes is based to a large extent upon the interaction of emulsin and amygdalin. This system has been subjected to much careful study (1, 3, 6, 9). Less is known about the interaction of other cyanogenetic systems such as prunasin-prunase and linamarin-phaseolunatase and very little about the highly important system dhurrin-dhurrinase which occurs in the sorghums.

Since the enzyme component regulates the rate at which HCN may be developed in a cyanogenetic system, the quantity or activity of that component in any given specimen of cyanogenetic plant is an important factor in the toxicity of the plant. Evidence accumulated in this laboratory during the past three years indicates that the active proportion of enzyme in cyanogenetic plants may vary considerably at different periods and under different conditions not only in the sorghums but also in species of wild cherry. The greater number of samples of sorghum appear to be deficient in dhurrinase, but occasional specimens occur in which there is ample enzyme to liberate the greater portion of the potential HCN in 3 hours. The wild-cherry species usually contain an abundance of enzyme, liberating all or nearly all the potential HCN in 2 to 3 hours, but rare samples occur in which the enzyme is deficient and cannot develop the entire quantity of potential HCN in the plant.

Variation in enzyme activity may explain the failure of some samples to produce poisoning in animals when chemical analysis indicates a toxic level of HCN. The lack of cyanogenetic enzyme in *Eremophila maculata* has been advanced by Finnemore and Cox (5) to explain the nontoxic nature of that plant when fed alone and its ability to produce HCN poisoning when some other material containing the enzyme is fed at the same time.

[1] Received May 9, 1940.

It is of interest to know whether the enzyme activity of plants like the sorghums bears any constant relationship to the quantity of potential HCN in the plant or whether these two factors may vary independently so that the rate at which the plant develops HCN may vary at different times. In the case of dried plants, such as hay, it is known that there is some loss of HCN during the curing process and the question of the effect upon the enzyme naturally arises. Some dried samples of sorghum and Sudan grass that have been kept for several years appear to have lost the greater part of their enzyme activity, although they retain considerable potential HCN. It is obvious that such hay would not be dangerous to livestock if the enzyme is insufficient to develop a toxic quantity of HCN when the hay is eaten. It is evident, therefore, that in some cases the quantity of enzyme present in the plant may be the factor that determines whether poisoning occurs. In view of these considerations it becomes highly desirable to work out some method whereby the activity or quantity of the enzyme can be evaluated. Until this has been accomplished it will be difficult to study the factors that influence the formation and storage of the enzyme in the living plant.

In attacking the problem of working out some method by which a numerical index could be assigned to the enzyme activity of a cyanogenetic plant, it was thought that some indication might be obtained by observing the percentage of the total potential HCN that might be obtained after various periods of maceration. A number of data were obtained in this way which, while they clearly indicated variation in the enzyme activity at different times, were not adapted to mathematical treatment and did not lead to any quantitative knowledge of the enzyme. Samples of these same plants to which an enzyme had been added and others to which a solution of the glucoside was added were run at the same time as the untreated samples. The purpose was to supply enzyme if that factor was deficient or in case the enzyme should be in excess to supply enough glucoside to get an index of the excess. In both cases the results, while informative, were not of such a nature as to yield a numerical index of the enzyme activity. The failure in these attempts may be due to the fact that in the decomposition of dhurrin or of prunasin, two enzymatic processes are occurring, the hydrolysis of the ether linkage with splitting off of the sugar molecule and the hydrolysis of the nitrile to produce HCN. Whether both of these reactions are catalyzed by the same enzyme or whether two enzymes are concerned is not known, nor have we any knowledge that one reaction takes precedence over the other or that the two proceed

concurrently. If one enzyme only is concerned and if one reaction proceeds more rapidly than the other, it is possible that the enzyme might be quite inhibited in partially hydrolyzing a large quantity of glucoside and thus produce very little of the completely hydrolyzed products. We have some evidence that in the case of dhurrin glucose is split off the molecule more rapidly than HCN. Should some of these possibilities be true, the problem of accurately evaluating the quantity of enzyme may be quite complex.

A study of the rate at which the enzyme hydrolyzes a definite quantity of glucoside should yield figures from which the approximate quantity of enzyme present could be inferred. This is especially true in the earlier stages of the process where, as shown by Auld (1) the reaction follows the law for monomolecular reactions. O'Sullivan and Tomson (8) used the time required for the performance of a certain amount of work as an index of the activity of invertase and the idea was applied to emulsin by Helferich (6) and by Willstätter and Csanyi (9). Helferich determined this "Zeitwertquotient" as the time required to hydrolyze 50 percent of substrate. The application of this method to plants is limited by the fact that it is not possible arbitrarily to alter the relative proportions of glucoside and enzyme present but one must accept the mixture as it naturally occurs. The addition of enzyme or glucoside to macerating plant mixtures is only partially satisfactory since much of the natural enzymolysis takes place within the plant tissues and there is considerable doubt that much of the plant enzyme goes into solution in the external fluid where the added glucoside is. On the other hand, there is little doubt that much of the added enzyme does not penetrate the plant tissues and come in contact with the plant glucoside.

EXPERIMENTAL

Twelve varieties of sorghum grown at the Bureau of Plant Industry Experimental Farm, Arlington, Va., were made available for this season through the courtesy of Dr. J. H. Martin, of the Bureau of Plant Industry, who helped in the selection of the varieties and arranged for the planting and cultivation of the crop. The 12 varieties studied were Dwarf Yellow milo, Ajax, Spur feterita, Sharon kafir, Grohoma, Sagrain, hegari, Leoti sorgo, Sumac sorgo, Kansas Orange sorgo, Rex sorgo, and Atlas sorgo.

It was planned to determine in each plant collection the HCN liberated without preliminary maceration and after water maceration for 1, 2, 3, 4, 24, and 48 hours, and after mercuric chloride preservation for 4 weeks, 8 weeks, and 6 months. When there was a shortage of material, certain of the least essential samples in this series were omitted. Samples were collected

TABLE 1.—HYDROCYANIC ACID RECOVERED FROM SORGHUM VARIETIES AFTER MACERATION FOR DIFFERENT PERIODS IN WATER AT 37° C.

Coll. no.	Date 1939	Variety	Moisture %	Height in.	Hydrocyanic acid (mg per 100g of dry plant) recovered after maceration in water: 0 hours	1 hour	2 hours	3 hours	4 hours	24 hours	48 hours	in $HgCl_2$ (a): 4 and 8 weeks (a)	Time at 50% hydrolysis hrs.	Rate index	Remarks
					mg	mg	mg	mg	mg	mg	mg	mg/%			
15	July 10	Hegari	88.11	8-10	18	27	56	133	172	242		309	3.4	45.6	Suckers
38	Aug. 8	do	89.29	10-12	38	50		209	274	328	304	402	3.	67.	2nd growth
45	Aug. 22	do	87.00	10-12	35	33		145	210	316	302	328	3.2	50.	do
14	July 10	do	86.26	12-14	16	16	33	88	191	290		309	3.4	45.6	
23	July 17	do	79.76	24	20	31	39	44	50	140	188	226	15.8	6.6	
27	July 24	do	81.96	24-26	24	34	43	66	75	139	151	228	24.	5.9	
31	July 31	do	78.21	48	10	21	35	35	35	207	199	246	10.3	12.	
36	Aug. 7	do	78.57	60	13	25	29		40	184	194	285	9.4	12.	
42	Aug. 14	do	76.48	72	11	16		29	30	103	172	206	24.	4.3	
44	Aug. 21	do	75.92	60-72	15	19		31	34	107	165	202	22.4	4.5	
46	Aug. 28	do	76.11	72	14	23		29	51	116	137	175	13.2	6.7	
49	Sept. 5	do	74.66	72	10	21		23	34	82	88	121	15.3	4.	
50	Sept. 18	do	71.36	72	10	17		29	34	56	70	93	10.	4.7	
51	Sept. 25	do	71.22	72	10	22		38	51	84	47	80 (b)	3.2	12.7	
54	Oct. 9	do	68.28	72	7	19			34	44		73	5.4	6.9	
58	Oct. 17	do	64.86	8-12	40	42		62	96	198	206	297	8.4	17.7	Frosted; 2nd growth.
57	Oct. 16	do	71.00	72	13	30		40	43	53	50	82 (b)	3.4	12.1	do
21	July 14	Spur feterita	88.47	6-8	28	27	69	149	209	278		285	3.	47.	Suckers
18	July 12	Kansas Orange sorgo	88.87	8	20	20	26	60	152	160	177	213	3.1	34.5	do
17	July 12	Leoti sorgo	86.95	8	18	20	31	75	107	135	112	205	3.8	27.1	do
22	July 14	Sagrain	88.74	8-12	15	17	49	115	160	127		201	2.7	37.	
5	July 6	Spur feterita	85.42	12	23		69	173		230		282	2.6	56.1	
4	July 5	Dwarf Yellow milo	85.24	12	23	20	61	138	146	213		266	2.8	47.5	
19	July 13	Ajax	85.81	12	15	15	29	65	120	143	148	220	3.1	32.3	
12	July 7	Atlas sorgo	87.68	12	17	17	51	115		133		239 (b)	3.6	33.3	
6	July 6	Orohoma	89.21	12	18		43	106		147		295	3.8	31.	
13	July 7	Rex sorgo	86.99	12	14		35	82		153		241 (b)	5.8	20.9	
24	July 18	Sumac sorgo	84.03	10-14	9	12	41	84	108	138	139	189	3.3	29.	Suckers
16	July 11	do	86.84	12-14	11	12	34	108	152	210		287	3.3	40.6	
20	July 13	Sharon kafir	85.88	12-14	8	8	17	35	56	53		101	3.7	13.8	
43	Aug. 15	Ajax	88.36	6-8	67	69		336	392	444	501	497	2.8	100.5	2nd growth
52	Sept. 26	Spur feterita	87.68	6-10	25	77		154	179	217	198	240	2.	60.	do
56	Oct. 11	Ajax	83.44	8-12	21	23		92	132	165	152	228	3.3	34.2	do
40	Aug. 9	Sharon kafir	80.48	10-12	22	26		86	107	139	136	185	3.2	28.6	do
47	Aug. 29	Dwarf Yellow milo	92.95	12-14	32	34		70	133	227	224	318	4.8	33.1	do
26	July 20	Spur feterita	85.15	20-22	42	59	82	99	128	256	256	273	4.4	31.	Suckers
25	July 19	Sharon kafir	82.54	24-26	16		33	39	42	61	50	91 (b)	9.4	8.4	
28	July 25	Sumac sorgo	81.79	36	13	29	48	65	73	131	141	184	9.3	9.9	
35	Aug. 4	Dwarf Yellow milo	79.21	36	11	21		40	47	115		124	8.3	8.6	
29	July 26	Sharon kafir	79.73	38-40	10	18	29	35	38	76	64	92	7.6	6.	
30	July 28	Atlas sorgo	82.70	48	14	18	33	40	55	72		88	3.2	13.6	
34	Aug. 3	Spur feterita	78.71	54	27	43		65	82	210	201	299	9.4	13.8	
33	Aug. 2	Sumac sorgo	80.12	72	10	15		42	47	139	116	152	12.	6.3	
41	Aug. 10	Sumac sorgo	76.56	72	12	19		38	45	86	135	165	14.4	5.6	

(a) Highest value in 4 and 8 weeks' maceration in mercuric chloride ($HgCl_2$) is given. (b) The 8-week sample was over 3% lower than the 4-week.

daily throughout the season at 8:30 A.M. and taken at once to the laboratory, where they were immediately sliced fine or ground for analysis. The whole plants were sliced so long as no pith was present. As soon as pith began to appear, that part of the stalk containing the pith was discarded. When the plants became fibrous and tough the leaves were stripped off and ground in a food chopper, the stalks and heads being discarded. Fifty-gram samples were used whenever sufficient material was on hand and the plant was weighed out (before grinding or slicing) in slight excess for the number of analyses planned. The sliced or ground plant was mixed thoroughly and weighed at once into flasks and jars assembled in advance. The samples for water maceration were placed in 5-liter round-bottom flasks and stoppered with a rubber stopper. Those for mercuric chloride preservation were placed in pint fruit jars. As soon as the last sample had been weighed, the contents of the jars were flooded with water and ½ gram (1 percent) of mercuric chloride in solution added to each. The jars were then filled to the shoulder with water, covered, shaken well and stored at 25° C. until the time of analysis. In the meantime a flask of water had been brought to boiling. For the time series it was necessary to stop all enzyme action promptly at the beginning of the analysis. This was accomplished quite effectively with boiling water and mercuric chloride. To the sample marked zero hours, 1,500 cc of boiling water containing 1 gram (2 percent) of mercuric chloride was added. The flask was connected to a condenser and the burner lighted at once. As soon as vapor began to condense in the delivery tube above the stopper, 2 grams of stannous chloride in water was added, the connections quickly reinserted, and without removing the flame the mixture was well shaken while holding the stoppers firmly in place. The HCN was then distilled off and caught in a 500-cc Erlenmeyer flask containing 10 cc of 5 percent potassium hydroxide. Two distillates of 400 cc each were taken for each sample. For the remaining samples a quantity of warm tap water sufficient for 500 cc per sample was run into a large container and adjusted to 37° C. To each flask was added 500 cc as rapidly as it could be measured in a graduate and the rubber stoppers reinserted. The flasks were placed at once in the incubator at 37° C. The whole operation of adding the water required from 3 to 6 minutes, depending on the number of samples in the series. When the period of maceration had elapsed for each sample, it was diluted to 1,500 cc with 1,000 cc of boiling water containing 1 gram (2 percent) of mercuric chloride. The flask was then connected, heated, stannous chloride added, and the contents distilled just as in the case of the zero hour sample. The HCN content of the distillates was determined as previously described (2).

The amount of HCN liberated each hour for the first four hours was determined in these experiments because an animal that is to become poisoned from sorghum will ordinarily show the effect within four hours. The animal will very likely not become poisoned if no effect is produced within four hours after the plants are eaten.

DISCUSSION OF RESULTS

The data obtained in the experiments are tabulated in Tables 1 and 2. The data in Table 1 are expressed in milligrams of HCN per 100 grams of plant calculated to the dry basis. Columns 6 to 12 give the figures for the amount of HCN liberated by water maceration during intervals of 0, 1, 2, 3, 4, 24, and 48 hours. The total amount of potential HCN in the plant as determined by 4 and 8 weeks of maceration in mercuric chloride is shown in column 13, the highest value thus obtained being given and the values similarly expressed in mg of HCN per 100 grams of dry plant. Column 14 gives

TABLE 2.—SORGHUM VARIETIES LIBERATING THE HIGHEST AND LOWEST PERCENT OF THE POTENTIAL HYDROCYANIC ACID FOR DIFFERENT PERIODS OF MACERATION OF THE SAMPLES IN WATER AND IN MERCURIC CHLORIDE

Time of maceration in water	Highest			Lowest		
	Variety	Coll. no.	HCN liberated	Variety	Coll. no.	HCN liberated
hrs.		1939	%		1939	%
0	Sharon kafir	25	17.6	Hegari	31	4.0
1	Hegari (frosted)	57	36.8	Sumac	16	4.5
2	Atlas sorgo	30	37.5	Hegari	14	11.2
3	Ajax	43	62.0	Hegari	42	14.1
4	Ajax	43	80.5	Hegari	31	14.2
24	Spur feterita	21	97.5	Hegari	55	41.2
48	Spur feterita	26	93.8	Leoti sorgo	17	54.6
In $HgCl_2$	Ajax	43	487 mg.	Hegari	54	73 mg.

the time in hours at which 50 percent of the potential HCN had been liberated. These values were obtained from graphs of the figures for the number of milligrams of HCN liberated against the time intervals 0, 1, 2, 3, 4, and 24 hours corresponding to these figures. Column 15 gives the rate index for 50 percent hydrolysis. This figure indicates the number of milligrams of HCN obtained per hour up to the time at which 50 percent of the potential HCN had been liberated and was calculated from the data in columns 13 and 14. The data in Table 1 are arranged according to height of plants. The number of milligrams of HCN liberated at the stated time for hegari are given in the first four sections of the table. Similar figures are given in sections 5 and 6 for 11 varieties of first-growth plants and 4 varieties (5 samples) of second-growth plants all less than 15 inches in height. The last section gives the figures for plants 2 feet or more in height for all varieties excluding hegari. Spur feterita, 20–22 inches high, was placed in this section although slightly less than 2 feet high. This sample is the exception mentioned in the next paragraph.

The data in Table 1 reveal the outstanding fact that young sorghum liberates HCN at a much higher rate than older plants. The rate index expresses this fact numerically. All the high values for the rate index are seen to be associated with the sorghums less than 15 inches in height, sections 1, 5, and 6, with one exception, namely, Spur feterita, 20–22 inches high in section 7, which has a rate index of 31 although it is nearly 2 feet in height. Another exception is Sharon kafir, section 5, young first growth which has a rate index

of 13.8 while the next lowest value in this section is 20.9. No explanation for these exceptions can as yet be given.

A comparison of first and second growth sorghum brings out the fact that some samples of second growth have an exceptionally high rate index. For example second growth Ajax with a potential HCN value of 487 milligrams has a rate index of 100.5 and Spur feterita has corresponding values of 240 and 60. The highest value for young first growth was that of Spur feterita with a potential HCN value of 292 milligrams and a rate index of 56.1. This comparison between first and second growth is well brought out by the re-

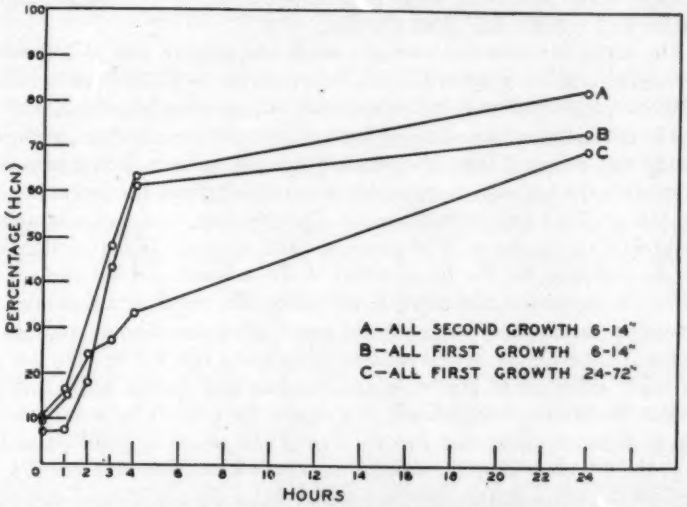

Fig. 1.—Average percent of the potential hydrocyanic acid liberated from sorghums after maceration in water for different periods of time.

spective averages calculated from Table 1, as given in Fig. 1, in which the percentages of the potential HCN liberated are plotted for the various time intervals. The curves show that 50 percent hydrolysis is reached earlier in the case of second growth plants so far as can be determined by a small number of samples.

The activity of the enzyme as indicated by the rate index is a factor determining the rate of evolution of HCN and hence the toxicity of sorghum. The high rate indices associated with young plants, including second growth, first growth and suckers, indicate that sorghum in its early stages of growth is a dangerous food for livestock. From the present state of our knowledge it is as yet impossible to say whether plants with low rate indices are toxic to animals when eaten in large quantities and if so what determines the toxic level for such plants.

The rate index is independent of the quantity of potential HCN in the

plant. A comparison of the amount of potential HCN in sorghum with the corresponding rate indices showed that there was no correlation between the two. Samples with a potential HCN content of 200 and 206 milligrams showed rate indices of 32.3 and 4.3, respectively. Similar discrepancies were numerous throughout the list.

It is of interest to note which varieties of sorghum liberated the lowest percent of the potential HCN and which the highest for the different periods of maceration in water and in mercuric chloride. Data for such a comparison are given in Table 2. Hegari is shown to be the lowest in 6 out of 8 instances and Sumac sorgo and Leoti sorgo each in one instance. Among the highest are Atlas sorgo, Ajax, and Spur feterita.

In Fig. 1 the curve or the averages of all first growth plants 2–6 feet in height shows a slowing up of the rate of evolution of HCN between the 2- and 3-hour points followed by an increase. All samples from plants of this size were ground in a food chopper for analysis. Hence a certain amount of glucoside and enzyme from the crushed sample were in intimate contact and therefore the hydrolysis proceeded more rapidly from the beginning than in the case of sliced first growth plants. The grinding, however, was not sufficiently fine to expose all the glucoside and enzyme and a certain time would be required for the penetration of the solvent and subsequent diffusion of the reactants and reaction products. The result is a slowing up of the reaction rate as indicated by the curve after the 2-hour point in the averages. Young plants, which contain more water and are less fibrous, permit a rapid diffusion of glucoside and enzyme and do not show this phenomenon. No analyses were made this season for periods between 4 and 24 hours. It is conceivable that this slowing of the reaction could occur later than at the 4-hour period in a sample with a slow reaction rate and if at the same time the curve in this area was rather flat a dip could occur due to the rate of destruction of HCN for a time exceeding the rate of its formation. Such a dip has been discussed in a previous publication (2).

It is of interest to calculate how much difference in toxicity the variation in rate of evolution of HCN would be expected to make. Taking the m.l.d. of HCN for cattle as 2 mg per kg and for sheep as 2.3 mg per kg, then on the basis of the average of actual HCN evolved from hegari in 4 hours, the 8–14 inch plants would furnish one m.l.d. for a 300-kg cow in 281 g of plant; the 24–26 inch plants in 1,215 g and the 6-foot plants in 1,378 g. For a 50-kg sheep the figures are: 53.8 g, 233 g, and 264 g. respectively. The potential HCN contents (average) of the plants are as 100: 71.7:32 percent.

SUMMARY

The activity of the enzyme determines the rate at which a cyanogenetic plant evolves HCN and so is a determining factor in the toxicity of the plant. Unless the enzyme is sufficiently active to evolve a toxic quantity of HCN quickly, poisoning is not likely to occur.

Young second-growth and first-growth plants including suckers have a much higher rate index than leaves of well-developed sorghum varieties and consequently are to that extent more likely to cause poisoning. Whether plants with a low rate index are toxic when larger quantities are eaten and if so what determines the toxic level for such plants are questions requiring further investigation.

The enzyme activity of a cyanogenetic plant may be numerically defined as the number of milligrams of HCN evolved per hour until 50 percent of the potential amount has been set free under certain conditions of temperature and dilution. The figure is referred to as the "rate index."

The rate index was determined for a number of varieties of sorghum collected at Arlington Farm during the summer of 1939. The rate index is high for young plants of all varieties less than 15 inches high and low for plants of all varieties above 2 feet high. The rate index is not correlated with the quantity of potential HCN and varies independently of it. Consequently the activity or quantity of the enzyme in the plants is not a function of the quantity of dhurrin.

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PALEOBOTANY.—*A bracket fungus from the late Tertiary of southwestern Idaho.*[1] ROLAND W. BROWN, U. S. Geological Survey.

The specimen to be described here was collected in 1939 by James L. Morris, registered engineer of Boise, Idaho, at a locality about 1½ miles east of a point 5 miles south on the highway from Bruneau, Idaho, to Owyhee, Nev. Associated with this specimen on the surface at the same locality is much fossil wood, which includes species of fir (*Abies*), alder (*Alnus*), poplar (*Populus*), oak (*Quercus*), and hickory (*Hicoria*). From a sketch and photograph submitted by Mr. Morris, it would appear that the fossils occur in a stratum lying just above a white bed of volcanic glass sand. These strata may be part of the Idaho formation, which in the course of its history has been made to include a rather heterogeneous series of lake and basin deposits lying above the Columbia River basalt. The presence of undoubted hickory among the fossil woods suggests a much moister climate than that now prevailing in the area, and it also suggests that the age of that part of the formation is probably not later than early Pliocene.

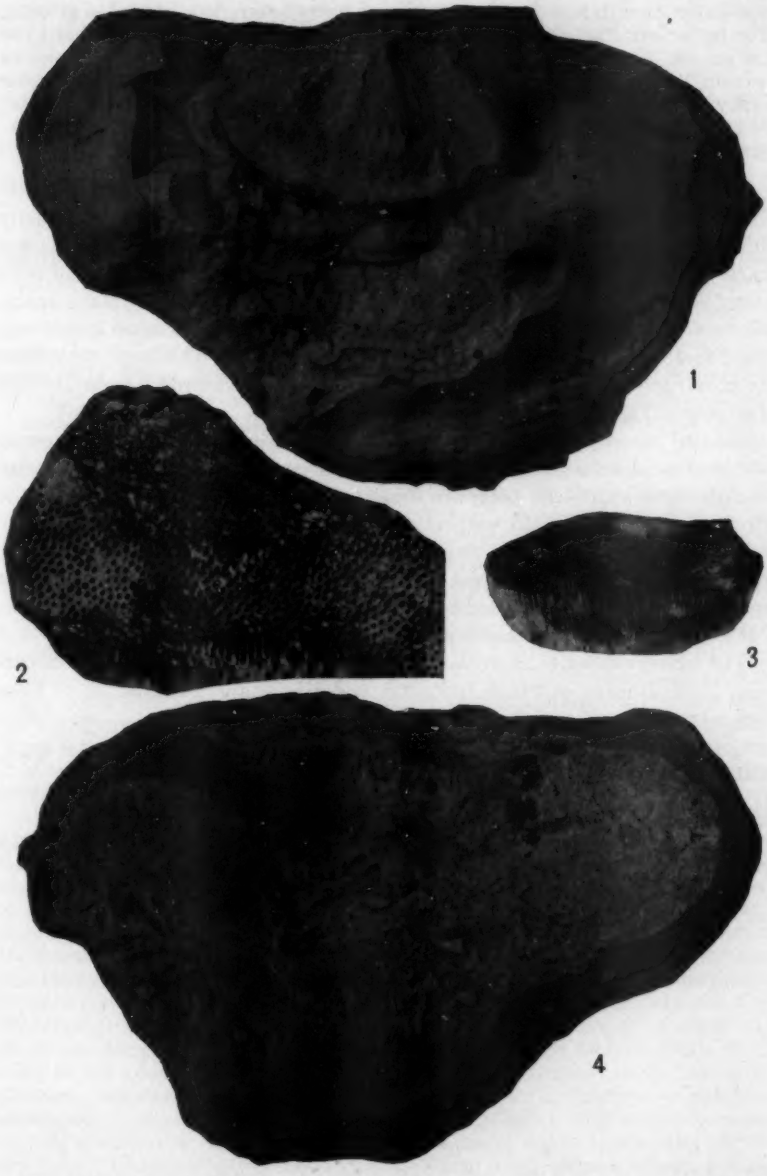
Analysis of the specimen shows that it is composed principally of calcium carbonate with minute amounts of other substances, some of which may have come from clay or other extraneous material lodged in the pores subsequent to the calcification of the specimen. The fact that this fungus and the woods are calcified, with preservation of the original cellular structure as perfect as the best examples of silicified specimens of the same kind, raises some questions that the writer can not answer at this time, such for example as: What was the probable immediate source of the calcium carbonate? Why did calcification take place instead of silicification? A thorough examination of the geological setting would doubtless throw light on these matters, but the writer has not had an opportunity to visit the locality. According to the sketch there are now hot springs 6 miles east of this locality, but whether these or similar springs that may once have existed closer by had anything to do with this fossilization is only conjectural. It would seem that definite answers to these questions might perhaps precipitate the long-sought solution to the problem as to how calcification and silicification take place.

POLYPORACEAE

Fomes idahoensis Brown, n. sp. Figs. 1–4

This specimen is the sporophore or spore-bearing portion of a bracket fungus. It is 13.5 cm long and 4.5 cm thick. The upper surface (Fig. 1) is or

[1] Published by permission of the Director, Geological Survey, U. S. Department of the Interior. Received May 29, 1940.



Figs. 1–4.—*Fomes idahoensis* Brown, n. sp.: 1, View of top; 2, pores, ×4; 3, side view showing context above and pore area below; 4, view of bottom. Figs. 1, 4, ×½.

was fairly smooth and displays a series of convex-rounded "rings" of growth. The under surface (Fig 4) is flat and porous, the pores numbering about 750 per sq. cm. These are shown in Fig. 2, magnified four times. Fig. 3 is a cross section through the right hand end of Fig. 4 and illustrates the vesicular corky context separated from the pore area by an irregular dark zone. Microscopic examination reveals no spores or other significant cellular structures.

The specimen resembles the living bracket fungus, *Fomes pinicola* (Swartz) Cooke, so closely that no doubt exists as to its affinities. The only difference appears to be in the size of the pores, which are slightly larger in the fossil, thus aggregating only about 750 per sq. cm as compared with about 1,000 in *F. pinicola*. The species of the genus *Fomes* attack many kinds of trees. *Fomes pinicola* is found on conifers generally and is not confined to *Pinus* specifically as the name might suggest. The fossil may have lived on one of the numerous species of conifers recorded from the late Tertiary of the western United States.

Mason[2] records *Fomes applanatus* (Persoon) Gillet from the Pleistocene of the Tomales Bay region, Calif. This appears to be the only other authentic American fossil polypore fungus. Those described by Wieland and Brown in 1934 and 1936, respectively, have since been shown by Brown[3] to have been misidentified. Seward[4] in 1898 accepted as authentic several records of Polyporaceae from Europe, the earliest being an Oligocene species of *Polyporus* described by Conwentz from the Baltic amber deposits. Meschinelli,[5] however, records a number of additional species.

The writer expresses appreciation for help in this study to John A. Stevenson, U. S. Bureau of Plant Industry, and Kiguma J. Murata, U. S. Geological Survey.

[2] MASON, H. L. *Pleistocene flora of the Tomales formation.* Carnegie Inst. Washington Publ. 415(4): 143, pl. 5, figs. 1, 4. 1934.

[3] BROWN, ROLAND W. *Two fossils misidentified as shelf-fungi.* Journ. Washington Acad. Sci. 28: 130–131. 1938.

[4] SEWARD, A. C. *Fossil plants.* 1: 207–222. 1898.

[5] MESCHINELLI, A. *Fungorum fossilium omnium hucusque cognitorum iconographia.* 1898.

BOTANY.—Oxytenanthera felix, *a new species of bamboo from Yunnan, China.*[1] Y. L. KENG, National Central University, Chungking, China. (Communicated by AGNES CHASE.)

The genus *Oxytenanthera* Munro comprises about 20 species, from tropical Asia, New Guinea, and Africa. The species here described is the first known from China.

Oxytenanthera felix Keng, sp. nov.

Culmi teretes, 9 m alti, ramis foliiferis (in specimine) usque 90 cm longis, 5 mm crassis, basi squamis glabris stramineis cinctis; vaginae sese arcte involventes, infima 12 cm longa, glabrae vel superiores pilis adpressis 0.5–1 mm longis strigosae; ligula firma, 3–4 mm longa, saepe bipartita; laminae saepissime 30–45 cm longae, 4.5–6 cm latae, acutissimae, glabrae, basi in petiolum 4–7 mm longum attenuatae, margine scaberulae vel veteres fere laeves; rami floriferi simplices, aphylli, subherbacei, usque 2.5 m longi, internodiis inferioribus circ. 15 cm longis, 9 mm crassis; spiculae dense fasciculatae vel plurimae in capita magna usque 5 cm crassa dispositae, pleraeque 4-florae, 16–20 mm longae, pallide virides vel ad maturitatem stramineae; glumae 1–3, late ovatae, 3–9 mm longae; lemmata ovato-lanceolata, 11–17 mm longa, multinervia, superiora convoluta, pungenti-mucronata; palea multo angustior, 11–15 mm longa, suprema convoluta, inferior bicarinata, carinis marginibusque superne longe ciliata; lodiculae nullae; stamina 6, filis inferne connatis, hyalinis, usque 15 mm longis, antheris 4–7 mm longis, apice minute hispidulo (interdum fere glabro) apiculatis; ovarius linearis, stipitatus, in stylum hispidulum circ. 1 cm longum attenuatus, stigmato uno, plumoso, circ. 9 mm longo.

Culms terete, 9 meters tall, the leaf-bearing branches (in specimen) arising singly from the nodes of the main culm or primary branches, about 6 mm thick and medullated with whitish-flocculose pith, covered at base with glabrous stramineous scales, about 90 cm long, the lower 4 internodes 6–16 cm long, glabrous; sheaths 10 on the upper part of the leafy branch, tightly overlapping, the lowermost 12 cm long, keeled or the midnerve prominent above, glabrous or the upper strigose with appressed hairs 0.5–1 mm long; ligule firm, prominent, 3–4 mm long, frequently 2-partite or sometimes concave at apex; blades mostly 30–45 cm long, 4.5–6 cm wide, with a strong midnerve and 10–13 secondary nerves on either side, cross-veined, sometimes obscurely so, acuminate-pointed, cuneate at base with a petiole 4–7 mm long, glabrous or the pale lower surface very sparsely strigose with appressed deciduous hairs, the margins scaberulous or in age nearly smooth; floriferous branches simple, aphyllous, up to 2.5 meters long, the lower greenish subherbaceous internodes about 15 cm long, 9 mm thick; spikelets densely clustered or numerous in large heads up to 5 cm thick, usually 4-flowered, 16–20 mm long, pale green or stramineous at maturity; rachilla joints very short or the nodes nearly approximate; glumes 1–3, broadly ovate, acute or obtusish, successively longer, 3–9 mm long (when 3, the first sometimes keeled, the keel ciliate, the second sometimes paleate), multinerved, cross-veined, glabrous or the margins ciliolate; lemmas ovate-lanceolate, 11–17 mm long (the lowermost sometimes only 7 mm long, broadly ovate, staminate), multinerved, the upper ones usually convolute, pungent-mucronate,

[1] Received April 30, 1940.

glabrous or the margins ciliolate above; palea very narrow (about 1.5 mm wide between the keels), 11–15 mm long, the uppermost convolute, the lower ones 2-keeled the keels and the inflexed margins long-ciliate above; lodicules none; stamens 6, the filaments connate into a tube around the pistil, hyaline, up to 15 mm long, the anthers 4–7 mm long, apiculate with minutely hispidulous tip (or sometimes nearly glabrous); ovary linear or somewhat enlarged at base when ripe, stipitate, hispidulous, attenuate into a hispidulous style about 1 cm long, then continuous with a plumose stigma about 9 mm long.

Type in the U. S. National Herbarium, nos. 1214319 (flowering specimen) and 1214320 (leaf-bearing specimen), collected on plain of the Nam Ha, between Muang Hai and Keng Hung, Yunnan Province, altitude 1,260–1,350 meters, February 15–17, 1922, by J. F. Rock (no. 2462).

BOTANY.—*Taxonomic relationships in the genus* Gossypium.[1]

S. C. HARLAND, Sociedad Nacional Agraria, Lima, Peru. (Communicated by T. H. KEARNEY.)

There have been three recent papers dealing with the classification of the genus *Gossypium:* Hutchinson and Ghose (1937), Hutchinson (1938), and Hutchinson (1939). The third of these is a condensed and modified version of the first two. The discussion of Hutchinson and Ghose (1937) on the taxonomy and relationships of the Asiatic cottons calls for no comment. It seems to the writer an accurate and painstaking attempt to straighten out a confused and complicated situation. The treatment of the other groups is less satisfactory. First, a slight error is made in the statement that *G. davidsonii* and *G. klotzschianum* do not cross with cultivated New World cottons. Both in fact do cross with Sea Island cotton (*G. barbadense* L.) but produce seedlings that, although germinating vigorously, die when young through a progressive necrosis of the cotyledons.[2] Exception must also be taken to the statement that the two Australian species *G. sturtii* and *G. robinsonii* are probably best classified with the New World diploid cottons. About *G. robinsonii* we know nothing except from herbarium specimens, so that it may be removed from the discussion. Information on the relationship of *G. sturtii* to other diploid species is derivable only from cytological sources (Webber, 1935, 1936, and Skovsted, 1937).

[1] Received June 14, 1940. The writer is indebted to Dr. T. H. Kearney and to Dr. H. J. Webber, who have read this manuscript and furnished valuable suggestions.

[2] Dr. J. M. Webber informs the writer (April 24, 1940) that he has obtained one plant from the cross *barbadense*×*davidsonii* which grew normally and flowered profusely, exhibiting the most typical Drosera scheme meiotic chromosome behavior ($13_{II}+13_{I}$) of any *Gossypium* hybrid yet examined.

Webber (1936) reported the following results in crosses between *sturtii* and New World diploids:

CROSS	TYPE OF CONJUGATION
sturtii × *amourianum*	$0_{II}+26_{I}$ (most) to 6_{II} 14_{I}
sturtii × *harknessii*	$0_{II}+26_{I}$ (most) to 4_{II} 18_{I}
davidsonii × *sturtii*	$0_{II}+26_{I}$ (most) to 5_{II} 16_{I}
thurberi × *sturtii*	26_{I} (all)

In a later communication Webber (1939) gave further data as follows:

CROSS	UNIVALENTS	BIVALENTS
G. sturtii × *G. armourianum*	24.08	0.96
G. sturtii × *G. harknessii*	24.56	0.72
G. davidsonii × *G. sturtii*	23.94	1.03
G. thurberi × *G. sturtii*	24.52	0.74

Skovsted (1937) presented cytological data on crosses between *sturtii* and (a) *davidsonii*, (b) *armourianum*, and (c) Asiatics. He gave the following results:

CROSS	UNIVALENTS	BIVALENTS	TRIVALENTS	QUADRIVALENTS
davidsonii × *sturtii*	14.95	5.32	0.10	0.02
sturtii × *armourianum*	8.45	8.20	0.25	0.10
Asiatic × *sturtii*	2.0–3.7	9.5–10.2	0.5–0.8	0.3–0.45

Here it is evident that *sturtii* is cytologically closer to the Asiatic cultivated cottons than to the New World diploids. Skovsted states that pollen mother cells with 13 bivalent chromosomes are found in the hybrids between Asiatic cottons and *G. sturtii* and between Asiatic cottons and *G. anomalum*, and again, "*G. anomalum* and *G. sturtii* separated in different directions and to different continents. They yet retain sufficient cytological similarity with Asiatic cottons to permit of fairly normal conjugation in their hybrids." If therefore *sturtii* is to be classed with any other group, it should, agreeing with Skovsted, go with the Asiatic and not with the American diploids. Webber, however (1939), obtained in the cross *herbaceum* × *sturtii* 21.56 univalents and 2.22 bivalents. Since cytological criteria disagree and genetical criteria are entirely lacking, owing to complete sterility of all recorded crosses, it seems best pending further evidence to put *sturtii* in a group by itself, as has been done by the writer (1939).

Some comments may now be offered on certain changes that Hutchinson and Ghose (1937) and Hutchinson (1937–38) propose to make in the taxonomic status of some species in the tetraploid New World cottons and that differ from the schemes put forward by the writer (1932, 1939).

The specific rank assigned *darwinii, tomentosum, barbadense,* and *taitense* is not in dispute, but regarding the remaining species, two species and one subspecies were recognized in the writer's first scheme (1932): (1) *G. hirsutum* L. (the American Upland of commerce); (2) *G. purpurascens* Poir. (the Bourbon group), including *G. punctatum* Sch. and Thon. (the *punctatum* group). Later, the writer (1939) tentatively and hesitantly gave specific rank to *punctatum.* Hutchinson and Ghose (1937) followed this scheme but changed the name *G. purpurascens* to *G. religiosum.* In a later communication Hutchinson made a further modification and proposed that *purpurascens* and *punctatum* should now be considered as varieties of *hirsutum* under the names var. *purpurascens* and var. *religiosum.*

Now since the writer disagrees with the first taxonomic change in so far as *purpurascens* is termed *religiosum,* and with the second change in so far as *purpurascens* and *punctatum* are made varieties of *hirsutum,* it seems to be necessary to discuss the interrelationships of *hirsutum, purpurascens,* and *punctatum* rather fully. Let us first define what we mean by the terms. By *G. hirsutum* L. we mean the huge and variable assemblage of forms comprised under the name American Upland cottons. The type of the species is in the Sloane Herbarium, B. M., vol. 294, p. 45 (Miller's specimen named by himself). It is important to note that the type herbarium specimen consists of a small branch with seven or eight leaves and two flowers (or buds). To use it as an accurate means of discriminating between the modern *hirsutum* and related species can be done only by a process of rationalization and might well be merely taxonomic pedantry.

A whole series of minor details of form which characterize *hirsutum* are not visible in the specimen. It can not be said, for example, whether the specimen is derived from a monopodial or sympodial plant, or whether the flower is really characteristically *hirsutum.* It is true that the very special leaf shape of *hirsutum* is present, and this delimits it from *barbadense,* a species in which this leaf shape is unknown. The process we have to go through, then, is this: We identify (rightly or wrongly) the type specimen of *G. hirsutum* L. with the modern *hirsutum.* We then compile a taxonomic description of *hirsutum* from modern material and in the process discover what are the characters of taxonomic significance, which probably are not visible in the original specimen and which really do characterize *hirsutum* and mark it off as a good species. We go through the same process with other species thought to resemble an original type specimen, and then, by using a combination of methods in which anatomy, morphology, ecology,

geographical distribution, and genetics all play a part, though in varying order of importance, we decide upon species nomenclature.

The question then is whether a detailed examination from the above points of view justifies the merging of *purpurascens* and *punctatum* into the species *hirsutum*. Such an examination must make use of the criterion proposed but not employed by Hutchinson and Ghose (1937) when they say: "In devising a satisfactory classification for the species determined by genetic study, it is necessary to use only such characters as are indicative of fundamental differences in genetic composition."

About the *punctatum* group little will be said in this article, since more genetical information is required before discussing its taxonomic position. It is obviously related to both Uplands (*hirsutum*) and Bourbons (*purpurascens*), and Lewton (1912) thought it worth while to describe a characteristic member of this group as a separate species, *G. hopi* Lewton.

The use of the specific name *G. purpurascens* Poir. to denote the Bourbon group was adopted by the writer (1932) from Watt (1907). The drawing of *G. purpurascens* Poir. (No. 44 opposite p. 250) so closely resembled the typical Bourbons in the writer's collection, particularly in the calyx shape, number of bract teeth, narrow, cup-shaped flower, and boll shape, that it seemed the most convenient name to adopt, more especially since the general description of the species given by Watt also conformed. It was recognized that the Bourbon group was related to the Upland group, but how distantly was not known.

Subsequently, descriptions were made of as many morphological

TABLE 1.—GENETICAL DIFFERENCES BETWEEN PURPURASCENS AND HIRSUTUM

purpurascens		*hirsutum*	
Gene	Character	Gene	Character
Not known		R^H	Red leaf.
R^P or R^B	Red leaf.	Not known	
S^P	Petal Spot (mutable on *hirsutum* background).	Not known	
Not known		S^H	Petal spot.
Not known		G^{LH}	Green lint.
C^{OP}	Corky (complementary).	Not known	
t	Naked seed (recessive).	Not known	
Not known		T	Naked seed (dominant).

characters as possible, and it was found that the means of many of them were intermediate between *barbadense* and *hirsutum*. In other characters, more especially the time of bursting of the anthers and the features of the filaments, the Bourbons differed from both *hirsutum* and *barbadense*. Genetical studies of crosses between Bourbon and Upland have also been conducted by the writer since 1926 and have revealed that the genetical differences between these two groups are very considerable. The main ones are given in Table 1.

MODIFIER COMPLEX DIFFERENCES BETWEEN PURPURASCENS AND HIRSUTUM

1. The modifier complexes affecting "crinkled" are completely different in *hirsutum* and *purpurascens*. The gene for "crinkled" of *barbadense* was transferred to a typical *purpurascens* (*morrilli* Cook, and Hubbard) by several repeated backcrosses, and then isolated by selfing. When crossed with *barbadense* crinkled and *hirsutum* crinkled, respectively, it gave the following results in F_2:

(a) *purpurascens* crinkled × *barbadense* crinkled.
Complicated series of forms from supercrinkled to pseudonormal.
(b) *purpurascens* crinkled × *hirsutum* crinkled.
Complicated series of forms from crinkled to pseudonormal.

The variation in grade of crinkled in the *purpurascens-hirsutum* cross, although very considerable, was rather less than in the *barbadense-hirsutum* or *purpurascens-barbadense* series. This set of results is probably the most important of those yet available in deciding on the taxonomic position of *purpurascens*, and indicates such a specificity in the crinkled modifier complex as to confirm *purpurascens* in its position as a good taxonomic species, perhaps occupying a position intermediate between *barbadense* and *hirsutum* but nearer to the latter.

2. The fact that the petal spot gene S^p of *purpurascens* becomes reduced in intensity and becomes mutable, also indicates differing modifier complexes in *hirsutum* and *purpurascens*.

STERILITY IN CROSSES OF PURPURASCENS AND HIRSUTUM

Some sterility has been noted in the F_2 of *purpurascens–hirsutum* crosses. Such sterility is not to be expected between varieties assigned to the same species.

CHARACTER DIFFERENCES

Some character differences between *purpurascens* and *hirsutum* are worthy of note.

CHARACTER	PURPURASCENS	HIRSUTUM
Flower shape	Narrow cuplike	Widely expanded
Anthers—time of bursting	Late	Early
Number of bract teeth	Few	Many
Leaf shape	Mean L/S* of 2.5	L/S about 1.6–1.8
Kidney seed	Known but rare	Not known

* L/S = Length of leaf ÷ length to sinus.

LEAF SHAPE

There are several allels for leaf-shape in *purpurascens*. The characteristic broad leaf of *hirsutum* is extremely rare in *purpurascens*, being present in one type only of 20 standard *purpurascens* types selected from widely differing localities.

BRACT TEETH

The mean number of bract teeth in *purpurascens* varies from 4.0 to 9.5 with a mean of 6.0 in the 20 types. This character appears to be of quite definite significance in *purpurascens*.

Table 2 shows the correlation diagram between leaf shape (L/S–

TABLE 2.—CORRELATION: LEAFSHAPE AND NUMBER OF BRACT TEETH
20 Representative Bourbons

Leaf Shape L/S	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	
3.4						112														1
3.3					114															1
3.2				230																1
3.1																				—
3.0																				—
2.9					12															1
2.8							59													1
2.7				161																1
2.6			158																	1
2.5			13		111		○													2
2.4			108						29											2
2.3					107	165		166		208										4
2.2																				
2.1														21						1
2.0									196 26											2
1.9						92														1
1.8												167							⊗	1
	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	
			3	2	4	3	1	1	3	1	—	1	—	1						

Mean number of bract teeth

The numbers in the squares refer to the type number in the World Collection.
○ = Mean of Bourbon Group.
⊗ = Approximate position of Upland.

length ÷ length to sinus), and number of bract teeth in a representative group of Bourbons. The position of a representative *hirsutum* is marked, from which it will be seen that the distribution of all the Bourbons is clearly demarcated from *hirsutum*.

SUMMARY

Enough has been said to make it evident that the Bourbon group is distinct from the Upland group on both morphological and genetical grounds. In the writer's view, the assemblage of Bourbons is a good taxonomic species and is as distinct from Upland as, say, *arboreum* is from *herbaceum*. Bourbon should continue to be known as *G. purpurascens* Poir. pending a better name.

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ENTOMOLOGY.—*Some new species of Syrphidae* (Diptera).[1]

FRANK M. HULL, University of Mississippi. (Communicated by E. A. CHAPIN.)

This paper describes some neotropical Syrphidae, some of which were collected by the author at Barro Colorado Island and others accumulated. Types are in the author's collection.

Mesogramma lyrata n. sp.

Male.—Length 6 mm. Head: Front and face pale yellow, cheeks black, antennae wholly pale orange, arista black on apical two-thirds. Vertex violet immediately behind the ocelli, brassy brown posteriorly. Thorax: With a median, bluish-gray, linear vitta outside of which it is very broadly brassy brown. Viewed from the rear there is sublaterally, above the complete yellow lateral margin, a light brown and then a dark brown vitta. Scutellum brownish yellow, diffusely darker brown upon the disk, its discal pile pale, its marginal pile black, the posterior part of mesopleurae and the upper part of sternopleurae pale yellow. Abdomen: Brownish orange, marked with

[1] Received June 6, 1940.

dark brown. First segment yellow, with a pair of posterior, slender, black fascia separated in the middle, not reaching the sides. Second segment with a posterior, marginally evanescent, complete brown fascia, a quite evanescent incomplete subbasal fascia which shows traces of connection with the posterior one. Third segment with a slender subapical brown fascia curving up for a short distance along the posterior margin, also reaching the posterior corner and near the midline turning sharply upward to form a pair of outwardly turned, comma-like brown spots. Fourth segment with similar pattern but only the comma-like brown spots apparent. Fifth segment and hypopygium brownish orange. Legs: Pale yellow, the anterior tarsi orange, the posterior tarsi brownish, the hind femora and tibiae with subapical and subbasal blackish annulae respectively. Wings: Clear hyaline, stigma pale yellow.

Holotype.—Male. August 30, 1938, Barro Colorado Island (F. M. Hull collector).

Mesogramma basilaris Wd. var. **flavocuneus** n. var.

Female.—Length 6 mm. Head: Face yellow, a small obscure blackish spot beneath vertex violet; the front flat, smooth, metallic. The sides sharply marked with pale yellow almost to the ocelli. Cheeks black, antennae grayish brown, orange below. Thorax: With a wide, metallic gray, median vitta and a similar sublateral one. Between these vittae are others which are dark, golden-brown or brassy, and in some lights themselves appear to be divided. Scutellum metallic black, the posterior part of the rim narrowly yellow. Humeri, the posterior part of mesopleurae, and the upper part of sternopleurae yellow. Abdomen: Black marked with yellow, the first segment largely black, the anterior corners and a narrow anterior margin yellow, second segment black with a pair of small oval yellow spots, rather widely separated in the middle of the segment and a quite narrow lateral margin reaching nearly to the posterior corners also yellow. Third segment with a pair of widely separated yellow basal spots, which on their median ends are widely produced in a posterior direction to just past the middle of the segment and at the same time slightly curving toward the midline. These posterior ends are rounded and the lateral, basal portion of the spot reaches to the lateral margin of the segment where it is just a little expanded posteriorly. Fourth segment with almost identical pattern. Fifth segment somewhat similar, the lateral portions wider, the median portion about the same but the two spots more closely approximated. Legs: Pale yellow, the anterior tarsi pale brown, the hind tarsi and a prominent subapical annulus on the hind femora black. Hind tibiae with faint brownish black annulae on either side of the middle. Wings: Hyaline, stigma pale brown.

Types.—Holotype and three paratypes: Females. Salada River, near Ceiba, Spanish Honduras, September 2, 1938 (F. M. Hull collector). One additional paratype, female, from Tuxtepec, Mexico, in the U. S. National Museum.

Baccha fiata n. sp.

Male.—Length 14 mm. Head: Face, cheeks, and front pale yellow, the front with a rhomboid, blackish spot of some size in the center, confluent with a smaller black spot just before the antennae and on each side of which are brownish triangles touching the eye margins. Pile of front and face erect, thick, and blackish, somewhat paler below. Antennae orange-brown, darker upon the upper part of the third joint, antennal pile black. Thorax: With four, dully shining, brassy black vittae upon a brownish-yellow background;

the sublateral vittae widest, interrupted at the suture; the submedian vittae connected at a spot opposite the suture and giving the impression of a narrow H. Between the several vittae the thorax is golden-pollinose. Thoracic pile thick, erect and dark brown, becoming reddish or yellow along the lateral margins of the mesonotum. Humeri and practically the whole of the pleurae, except for a tiny spot below the base of the wing, light yellow. Scutellum light yellow with a subtranslucent, transverse fascia. Abdomen: Chiefly brownish orange, flattened and spatulae, the first segment pale yellow except for a narrow posterior margin, the second segment with a narrow yellow posterior margin and a pair of prominent, hyaline, rectangular windows in the anterior corners. Third segment wholly orange except for a narrow subapical, narrowly attenuated black fascia, interrupted in the middle and not reaching the sides. Fourth segment similarly colored. Fifth almost wholly orange. Legs: Pale brownish orange, more yellow upon the anterior pair. Hind femora with thick, very long, shaggy, reddish pile and some black pile at its base and on hind trochanters and coxae. Wings: Hyaline, with a sharply marked brown band along the anterior margin.

Holotype.—Male. Petropolis, Brazil, March 1, 1914.

Salpingogaster halcyon n. sp.

Male.—Length 17 mm. Head: Cheeks and face and upper part of front pale yellow. Greater anterior portion of front is black, expanded triangularly to the sides and to the eye margin. Antennae dark brown, first joint nearly black. Thorax: Obscurely shining black with three obscure, dark, reddish-brown vittae on the anterior two-thirds, and viewed from behind a more or less square area covered with pale yellowish-gray pubescence that is rather prominent. Pleurae black. The humeri, propleurae, notopleurae, a wide conspicuous oblique cuneiform stripe upon the posterior part of the mesopleurae, upper sternopleurae, anterior pteropleurae, and a second spot upon the anterior part of the metapleurae all pale yellow. Scutellum pale yellow with a transverse brown fascia not reaching the sides in the middle. Abdomen: Slender, with a prominent median black vittae from base of second segment to apex. First segment pale yellow with a diffuse light brown posterior margin. The anterior corners of the second segment and the narrow sides, as well as the somewhat wider sides of the third segment are pale yellow but diffuse. The apical portion of the sides of the third segment as well as the fourth segment reddish brown. Legs: Light yellow, the posterior tarsi, apical two-thirds of posterior tibiae, base and apical annulus of hind femora obscurely blackish or dark brown. Pile of anterior legs yellow, except on fore tarsi; black on the entire hind legs. Wings: Pale brown, strongly yellow on the basal half anteriorly, the stigmal cell very dark brown, the marginal cell somewhat lighter brown.

Holotype.—Male, Barro Colorado Island, August 28, 1938 (F. M. Hull collector).

ZOOLOGY.—*A new species of phyllopod crustacean from Stone Mountain, Georgia.*[1] EDWIN P. CREASER, U. S. Fish and Wildlife Service. (Communicated by WALDO L. SCHMITT.)

On June 8, 1939, I was informed by Don E. Eyles that certain fairy shrimps were occurring in rain pools on the summit of Stone Mountain in DeKalb County, Ga. Mr. Eyles had been requested to be on the watch for these crustaceans, as he was studying these pools and a few specimens new to science had previously been found at this location. Accordingly, on June 9, 1939, I climbed to the summit of the mountain, amid a rain and hail storm, and obtained a fine series of these phyllopods.

These crustaceans inhabited shallow rock pools 3 to 6 feet in diameter with fine silt bottoms, occurring in water not exceeding 4 inches in depth. They were found in company with a bloodworm (chironomid larva?) and a species of *Eulimnadia* (Phyllopoda: Conchostraca), which is possibly also undescribed and which is being studied by Prof. J. G. Mackin. These phyllopods prove to belong to the genus *Chirocephalus*, another species of which is widespread throughout Europe. The genus has not previously been recorded from North America. The species, *Chirocephalus lithacus*,[2] is here described for the first time.

Dr. A. S. Pearse very kindly arranged the loan of some microscopic equipment needed during the course of this study.

BRANCHIPODA

PHYLLOPODA: ANOSTRACA

Family CHIROCEPHALIDAE

Chirocephalus lithacus, new species

Description.—Male: Total body length of adult, 8.3 to 10.5 mm. Frontal appendage rising from middle of head as a single organ, then dividing into two similar branches, each branch in turn terminating in two lateral branches, one of which is club-shaped and armed at apex with a stout spine and studded over entire surface with papillae of probable sensory nature; the other branch laminate, with fingerlike weak spines along margins. Each branch of frontal appendage about 3 mm long. Clasping antenna sickle-shaped; basal article half length of terminal article. Inner margin of terminal article with fine oblique grooves. First antennae shorter than terminal article of clasping antennae. Eyes stalked, with greatest diameter less than 0.5 mm. Abdominal segments consisting of genital-bearing segment, 7 postgenital segments, and cercopods. Cercopods uniformly tapering, with setae of approximately one-fourth total length of cercopod. Swimming appendages with one branchial lamina.

[1] Received June 5, 1940.

[2] The name *lithacus* was suggested for this animal by Dr. Carl L. Hubbs. Translated from the Greek, it means of a stony place.

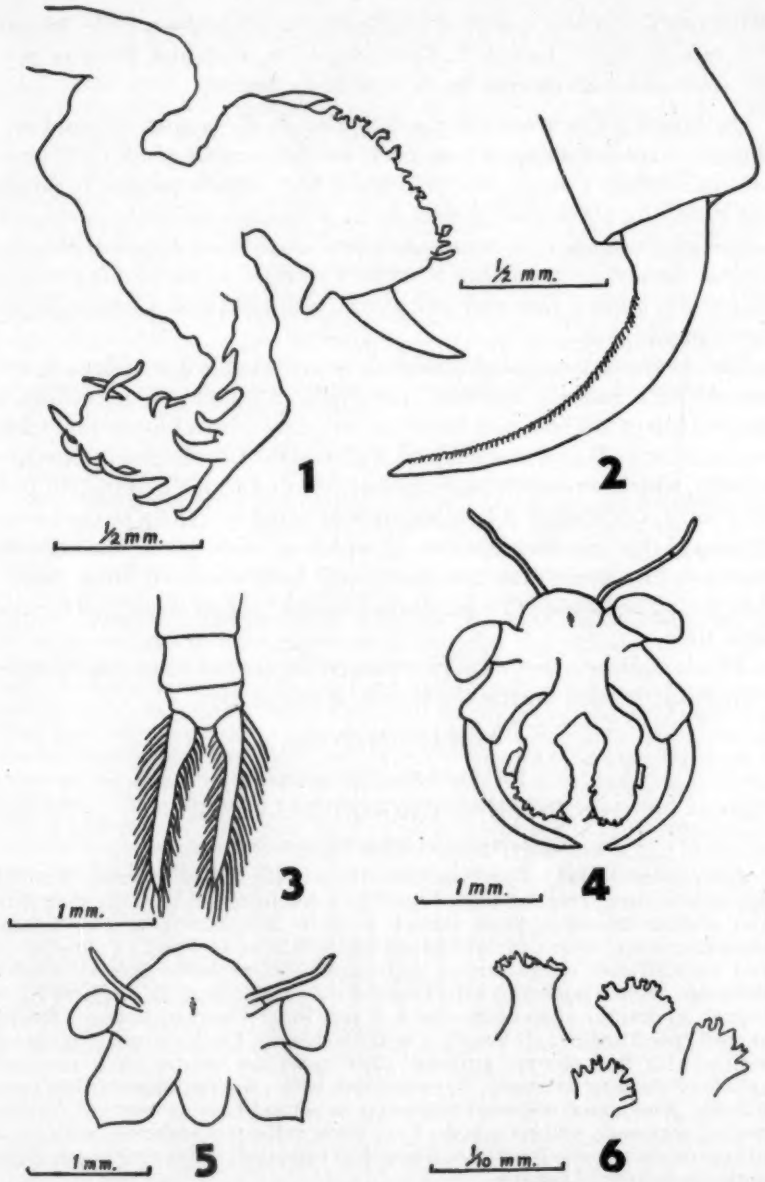

Fig. 1.—Frontal appendage. Fig. 2.—Clasping or second antenna of male. Fig. 3.—Male cercopods. Fig. 4.—Front view of head of male. Fig. 5.—Front view of head of female. Fig. 6.—Papillae of frontal appendage of male.

Female: Total body length of adult, 10.5 to 11.1 mm. Frontal appendage absent. First antennae about as long as clasping antennae. Clasping antennae flattened, pointed at apex, uniformly rounded on margins. Eyes stalked, with greatest diameter less than 0.5 mm. Ovisac one-half as long as abdomen with cercopods excluded. Ovisac gourd-shaped, not uniformly tapering, with apex turned abruptly toward the abdomen. Cercopods uniformly tapering, with setae of approximately one-fourth total length of cercopod.

Remarks.—This species may be distinguished from other North American phyllopods by the shape and structure of the bilaminate male frontal appendage and by the sickle-shaped appearance of the clasping antennae.

Types.—I collected the types of this new species in temporary pools in the granite rock on the summit of Stone Mountain, DeKalb County, Ga., within 100 yards of the airway beacon, June 9, 1939. They have been deposited in the United States National Museum: Holotype male, no. 79294; allotype female, no. 79295.

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ZOOLOGY.—Cercaria pricei, *a new trematode, with remarks on the specific characters of the "Prima" group of Xiphidiocercariae.*[1]

MIRIAM ROTHSCHILD, London, England. (Communicated by E. W. PRICE.)

It is not an unusual phenomenon to discover several very closely related species of larval trematodes parasitizing the same host. *Cercaria pricei* n. sp., described in this paper, is the third species of the "Prima" subgroup of Cercariae ornatae (Lühe, 1909) to be found in the snail *Pseudosuccinea columella* Say. Although this type of cercaria was originally recorded from Europe, almost all the important experimental work on their life histories has been carried out in brilliant fashion by Krull (1931, 1933) and other workers in the United States.

The individual author's spelling of host names is used herein. Furthermore the generic and specific names of the adult fluke used by the author in his description of its cercaria and life history are retained to avoid confusion.

I should like to express my gratitude to Dr. E. W. Price for his kindness in affording me every facility for work during my unexpected visit to Washington at the outbreak of the European war, to the Spen-

[1] Received June 3, 1940.

cer Lens Company for lending me superlative microscopical apparatus and to Dr. J. P. E. Morrison and Countess Mary Roberti for assisting in the collection of specimens.

CHARACTERS OF THE "PRIMA" SUBGROUP OF CERCARIAE ORNATAE

Sewell (1922) recognized that certain species of "Ornatae" Xiphidiocercariae formed a compact natural group of which *Cercaria prima* Sinitzin, 1905, was selected as the "type." Sewell's definition can be emended on several unimportant points. He regarded only the stem of the Y-shaped excretory bladder as the bladder proper and described the crura as dilatations of the excretory tubes. The subsequent development of the bladder in the metacercaria shows that this is erroneous. Two species with six pairs of penetration glands have also been discovered since 1922.

McMullen (1937) has shown that the presence or absence of a tail fin-fold may not be a character of great importance when forming a natural classification within a large group like the Plagiorchioidea. With this opinion I am in entire agreement. In the matter of tail structure and modification or loss of fins there is repeated evidence of parallel evolution in distantly related genera within one superfamily.[2] McMullen writes:

> In the cercariae of the frog lung flukes and related forms a similar situation arises. The cercariae of these trematodes . . . all have a fin-fold on the tail except the cercaria of *Haplometra cylindracea*. Here the absence of the fin-fold would, in the present classification, eliminate this form from the Ornatae group of Xiphidiocercariae and thus separate it from closely related forms. It seems probable, therefore, that the fin-fold of the tail and other such larval modifications are of little more than specific value in the Xiphidiocercariae.

However, the adult forms of "Prima" cercariae have all proved to be frog lung flukes of the subfamily Haematoloecinae Freitas and Lent, 1939 (=Pneumonoecesinae Mehra, 1937). *Haplometra cylindracea* Zeder is not in my opinion closely related to this subfamily, and in the opinion of Mehra (1937) it pertains to another family altogether. The absence of a tail membrane in this cercaria is therefore not considered to have any special bearing on the subgroup now under consideration, and the presence of a "Prima" type of fin-fold is for the present retained as a diagnostic character.

[2] Another type of parallel evolution to be found in the tail structure of cercariae is worthy of note. This may be typified by the giant tails found in unrelated cercariae which are swallowed as free swimming organisms by fish, for example, *Petasiger nitidus* Linton, 1928 (Echinostomidae) and *Proterometra macrostoma* (Faust, 1918) (Azygiidae).

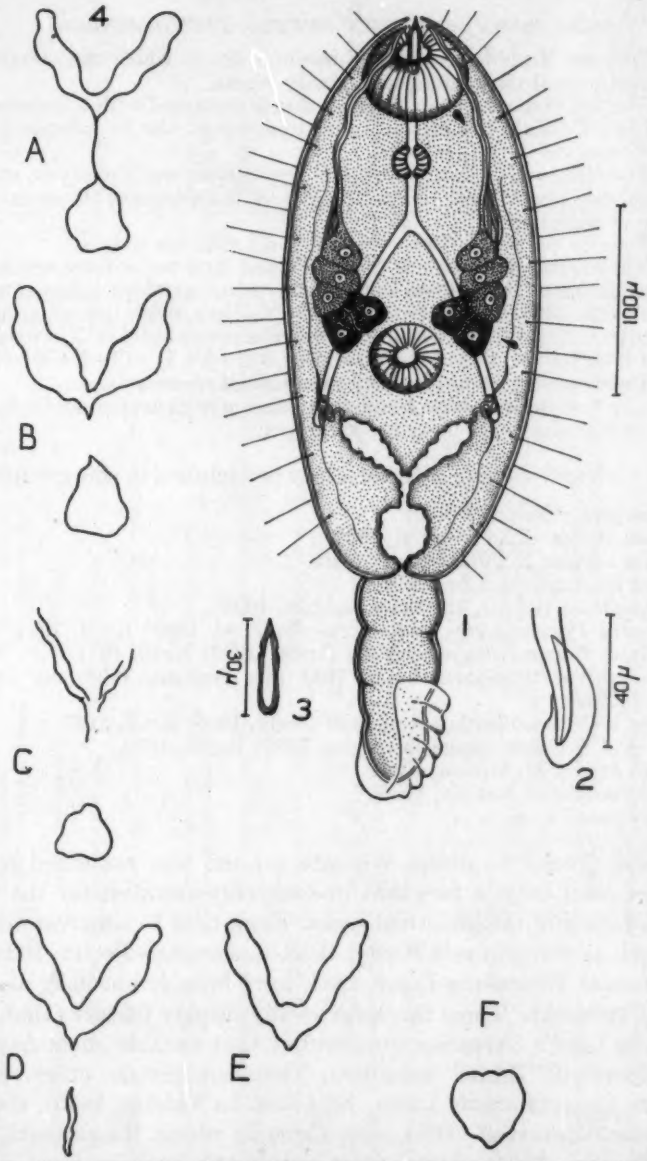

Fig. 1.—Diagram of *Cercaria pricei* from ventral aspect with tail contracted (penetration glands shown slightly larger than in reality. Fig. 2.—Fin-fold under pressure of a coverslip. Fig. 3.—Stylet. Fig. 4.—A–F, Diagrams showing appearance of excretory bladder during different stages of contraction.

THE "PRIMA" SUBGROUP SEWELL, 1922 (EMENDED)

(1) Distome Xiphidiocercariae of medium size in which the acetabulum is situated behind the middle of the body length.

(2) The tail is shorter than the body and is furnished with a dorsoventral fin-fold in its distal portion; the ventral portion of the fin extends farther forward than the dorsal portion.

(3) The alimentary canal possesses a prepharynx and a pharynx, and the intestinal caeca reach back to a point between the margin of the acetabulum and the posterior end of the body.

(4) Four to six pairs of penetration gland cells are present.

(5) The excretory bladder is Y-shaped and does not extend beyond the lateral margins of the ventral sucker. The main excretory tubes enter the bladder at the extremity of the arms of the Y. They divide into anterolateral and posterolateral branches at the level of the ventral sucker. The excretory pattern is $2[(1+1+1)+(1+1+1)]=12$ or $2[(3+3+3)+(3+3+3)]=36$.

(6) Development occurs in small unbranched sporocysts.

(7) The first intermediate hosts are fresh-water gastropod mollusks, and the second intermediate hosts are arthropods.

Thirteen species may with certainty be included in this group:

Cercaria prima Sinitzin, 1905.
Cercariae indicae XXIV Sewell, 1922.
Cercariae indicae XXVIII Sewell, 1922.
Cercaria longistyla McCoy, 1929.
Cercaria prima Dubois, 1929 (*nec* Sinitzin, 1905).
Cercaria of *Pneumonoeces medioplexus* (Stafford, 1902) Krull, 1931.
Cercaria of *Pneumobites parviplexus* (Irwin, 1929) Krull, 1931.
Cercaria prima Wesenberg-Lund, 1934 (*nec* Sinitzin, 1905, *nec* Dubois, 1929).
Cercaria of *Haematoloechus complexus* (Seely, 1906) Krull, 1933.
Cercaria of *Ostiolum oxyorchis* (Ingles, 1932) Ingles, 1933.
Cercaria herberi McMullen, 1938.
Cercaria merchanti Rankin, 1939.
Cercaria pricei n. sp.

Of these species *C. prima* Wesenberg-Lund was examined from a crushed snail only, a fact that undoubtedly accounts for the undeveloped state of the intestinal caeca. From time to time various species such as *Cercaria pela* Porter, 1938, *C. elemensis* Porter, 1938, and *C. laticauda* Wesenberg-Lund, 1934, have been erroneously assigned to this subgroup. These larvae generally display features that place them in Lühe's Cercariae ornatae but that exclude them from the circumscribed "Prima" subgroup. There are certain other species, such as *Cercaria ornata* Lutta, 1934 (*nec* La Valette, 1855), *Cercaria pratensis* Skwortzoff, 1924, and *Cercaria prima* Ruszkowski, 1925 (*nec* Sinitzin, 1905), whose exact systematic position must remain doubtful until more adequate descriptions are available.

TABLE 1.—DATA ON 13 SPECIES OF CERCARIA IN THE "PRIMA" GROUP

Species of Cercaria	First intermediate hosts	Second intermediate hosts	Number of penetration gland cells (pairs)	Size of stylet
Cercaria prima Sinitzin, 1905	*Apleza hypnorum*, *Planorbis vortex* var. *compressa*.	Larvae of *Corethra* and *Ilybius* (Ephemeridae).	5	25μ in length.
Cercariae indicae XXIV Sewell, 1922	*Limnaea succinea*.	Unknown.	4	?
Cercariae indicae XVIII Sewell, 1922	*Limnaea acuminata*.	Unknown.	4	0.028 mm.
Cercaria longistyla McCoy, 1929	*Physa integra*, *P. anatina*.	Dragonfly larva, small water insects.	5	32 by 4μ.
Cercaria prima Dubois, 1929 (*nec* Sinitzin, 1905)	*Apleza hypnorum*, *Lymnaea palustris*.	*Asellus aquaticus*.	4	29–33μ long, 4.5–6μ wide.
Cercaria of *Pneumonoeces medioplexus* (Stafford, 1902)	*Planorbula armigera* (Say).	*Sympetrum obtrusum* (Hagen), *S. rubicundulum* (Say).	6 (probably)	17.5μ by 2.36μ.
Cercaria of *Pneumobites parviplexus* (Irwin, 1929)	*Gyraulus parvus* (Say).	*Sympetrum obtrusum* (Hagen), *S. rubicundulum* (Say).	5 (probably)	19.9μ in length.
Cercaria prima Wesenberg-Lund, 1934 (*nec* Sinitzin, 1905; *nec* Dubois, 1929)	*Planorbis albus*.	Unknown.	4	No measurements of fully developed cercaria.
Cercaria of *Haematoloechus complexus* (Seely, 1906)	*Pseudosuccinea columella* Say.	*Sympetrum vicinum*, *Pachydiplax longipennis*, *Holotania* (*Libellula*) *incesta*, *Chromagrion conditum*, *Enallagma divagans*, *Lestes vigilax*, *Tetragoneuria cynosura* Say, *Argia* sp.	5	30μ average length, 5μ average width.
Cercaria of *Ostiolum oxyorchis* (Ingles, 1932)	*Planorbis* (*Gyraulus*) *parvus* Say, *Planorbis* (*G.*) *vermicularis* Gould	*Plathemis lydia* (Drury), *Sympetrum illotum* (Hagen).	?	22μ in length.
Cercaria herberi McMullen, 1938	*Physella magnalacustris* (Walker)	Mosquito larvae, Dragonfly naiads.	6	0.034 mm (length).
Cercaria merchanti Rankin, 1930	*Pseudosuccinea columella* Say.	Dragonfly nymphs, Damselfly nymphs.	5	0.04 by 0.004 mm.
Cercaria pricei n. sp.	*Pseudosuccinea columella* Say.	Unknown.	5	30–34μ by 4.2–5.1μ

SPECIFIC CHARACTERS OF THE "PRIMA" SUBGROUP

Judged from the descriptions by such excellent observers as Krull and Sewell it is only a little less difficult to distinguish between these larvae than certain heterophyid, notocotylid, and microphallid cercariae. Up to a point the same difficulties are encountered as those indicated for Opisthorchioidea cercariae (Rothschild, 1938). Measurements of soft parts can only be regarded as supplementary data, although in some cases the discrepancy in size is so great that it can not be due to difference in the technique adopted by individual observers. Measurement of the stylet is, however, of much importance. As in other groups, the relative degree of development and transparency of certain organs, such as sensory setae, cuticular spines, intestinal caeca, reproductive anlage, etc., are specific differences that do not lend themselves well to written descriptions. Perhaps one of the most tantalizing characters of this type is the relative thickness or toughness of the cuticle. The cercaria of *Pneumobites parviplexus*, for example, fragments after a few seconds under a coverslip, whereas *C. pricei* n. sp. remains intact for many hours. This is no doubt an extreme case, but in comparing cercariae almost every worker comes across subtle differences of this type that, although very obvious, can not be accurately described and at times even defy analysis.

The number and arrangement of penetration glands can vary specifically, but as the range is small this may not be very helpful (Table 1). The ducts apparently can open at the base or the tip of the stylet (*C. indicae* XXVIII, *C. indicae* XXIV). The shape and color of the parthenitae, together with the number of cercariae maturing simultaneously within each sporocyst, also vary specifically, but the age of an individual infection and the temperature of the water (Rothschild, 1935) appear to exert some influence upon these characters. Two different excretory patterns are met with. In one the full complement of flame cells found in the adult fluke is already developed, and in the other each group is represented by one flame cell only. No more than three patterns have been completely worked out. The distribution of sensory setae may be of much importance, but apparently in many cases these structures are not visible to the ordinary observer. Sinitzin undoubtedly possessed superior eyesight and described them in wonderful detail for nearly all his cercariae. The accuracy of his observations is verified from time to time when a species is found in which they are more obvious than in others.

TABLE 2.—BEHAVIOR OF CERCARIA

Species of Cercaria	Time of emergence from snail host	Duration of free swimming life	Tropisms	Other characteristics
Cercaria of *Ostiolum oxyorchis* (Ingles)	Afternoon and night.	About 24 hours.	No reaction to light or darkness.	Swim at all levels of water.
Cercaria of *Haematoloechus complexus* (Seely)	Throughout day.	?	?	
Cercaria of *Pneumobites parviplexus* (Irwin)	During afternoon.	?	No heliotropic response.	Uniformly distributed throughout water except in cool of morning, when swims sluggishly near bottom of container.
Cercaria of *Pneumonoeces medioplexus* (Stafford)	Chiefly during night.	?	Do.	Do.
Cercaria herberi McMullen	?	?	?	Good swimmer.
Cercaria merchanti Rankin	?	?	Positively phototropic; negatively geotropic; some response to shadow.	Rapid and constant swimmer.
Cercaria indicae XXIV Sewell	?	?	?	Somewhat feeble swimmer.
Cercaria pricei n. sp.	Throughout day.	About 9 hours (at room temperature in tap water).	No response to light or shadow. Occasionally swarm around objects in water.	Swims at all levels of water. Frequently dies fixed and flattened against sides of container.

Specific descriptions of "Prima" cercariae can be based on the following characteristics:

(1) Size:
  (a) Relative length of body and tail.
  (b) Relative size and position of suckers, pharynx,[3] prepharynx, and esophagus.
(2) Shape and dimensions of stylet (see Table 1).
(3) Precise extent and shape of caudal fin-fold.
(4) Behavior (see Table 2):
  (a) Time of emergence from the snail host.
  (b) Duration of free swimming life.[4]
  (c) Tropisms.
  (d) Choice of second intermediate host (including negative data).
(5) Cyst:
  (a) Shape (see Dubois, 1929, p. 56).
  (b) Size.
  (c) Location.

Supplementary characters:

(6) Excretory pattern.
(7) Number of penetration gland cells.
(8) Distribution of sensory setae.
(9) Presence of sensory papillae.
(10) Sporocysts:
  (a) Shape.
  (b) Color.
  (c) Number of cercariae maturing simultaneously within each sporocyst.

It is probable that these characters are valid for differentiating between other subgroups of Cercariae ornatae such as the "Hemilophura" subgroup. These differ essentially from "Prima" cercariae in the possession of an I-shaped excretory bladder, a fin-fold extending along the whole or two-thirds of the ventral side of the tail but not along the dorsal side, and elongated "worm"-shaped sporocysts. Variation in behavior has also been noted. The cercaria of *Macroderoides typicus* emerged "in the mid-morning hours . . . and died within a few hours" (McMullen, 1935), whereas the cercariae of *Haplometrana utahensis*, "are shed throughout the day and night with the greatest numbers appearing towards the evening . . . and lived as long as 40 hours" (Olsen, 1937).

[3] The conspicuously large pharynx of the cercaria of *Ostiolum oxyorchis* is also a feature of the adult fluke.

[4] The term "duration of free swimming life" I understand to mean the period during which the cercaria is capable of swimming in the water after natural emission from the snail host (Rothschild, 1938), and not the period during which the cercaria manifests movement or "signs of life." In most instances the latter character does not lend itself so well to accurate and clear cut comparison (Dubois, 1929), although it is useful as supplementary data (Wheeler, 1939).

Cercaria pricei,[5] **n. sp.** **Figs. 1–4**

Description.—Xiphidiocercaria of the "Prima" type, with the characters of the group. Measurements in microns (under light pressure of coverslip): Body length 375 to 257, mean 327; width 149 to 107, mean 135. Tail length 232 to 166, mean 200; width 49 to 41, mean 45. Fin 41 long ventrally, 22 dorsally; maximum width 17. Oral sucker 68 by 68 to 51 by 51, ventral sucker 44 by 51 to 31 by 41. Pharynx 25 by 22, prepharynx length 11.9 to 15.3; esophagus length 25. Stylet 30 to 40 by 4.2 to 5.1. Sporocyst (maximum) 249 by 124.

Body regularly oval in outline. Tail when extended two-thirds length of body, when contracted one-half length of body. Ventral sucker slightly more than half diameter of oral sucker, situated somewhat less than two-thirds of body length from anterior extremity. Esophagus short, barely longer than pharynx. Intestinal caeca well developed. Five pairs of penetration gland cells of which the posterior three pairs are coarsely granular, slightly larger, and dorsal to the two anterior pairs. Ducts of glands arranged in two groups opening near anterior extremity of stylet. Crura of bladder not reaching posterior border of ventral sucker. Cuticle faintly rugose, without spines or sensory tubercles. Two rows of long sensory setae along lateral edges of body, arranged as in *C. prima*. Parthenitae stumpy, sausage-shaped, pale yellow; one to two cercariae maturing simultaneously within each sporocyst.

Behavior.—The cercariae emerge throughout the day, the length of free swimming life being nine hours in tap water at room temperature.

No phototropic responses.

First intermediate host.—*Pseudosuccinea columella* Say.

Locality and date of collection.—Shaw Lily Gardens, Washington, D. C., September-October, 1939.

Remarks.—*Cercaria pricei* most closely resembles the Cercaria of *Haematoloechus complexus* described by Krull and *Cercaria merchanti* described by Rankin, both from the same host. It can be separated from the former by its much greater size, number and arrangement of sensory setae, the relatively shorter prepharynx, and greater distance between the fork of the intestine and the ventral sucker. In *C. merchanti* the forks of the Y-shaped bladder extend to the lateral borders of the acetabulum; the long sensory setae are absent but sensory tubercles are present around the oral sucker; the stylet is narrower in comparison with its length; and there are also differences in behavior (see Table 2).

One of the most striking features of *C. pricei* is the periodic contractions of the bladder. First the cavity of the stem is obliterated and then the branches of the Y. This curious phenomenon is not mentioned by either Krull or Rankin, but Ingles (1933) has noted it for the Cercaria of *Ostiolum oxyorchis*, and Miller (1935) and Dubois (1929) record it for "Polyadena" cercariae. Krull's drawing of the bladder of the Cercaria of *H. complexus* does not entirely agree with the description, and in fact the bladder figured for *Cercaria tricystica* Miller, 1935, *C. helvetica* V Dubois, etc., more closely

[5] Named for Dr. E. W. Price, of the U. S. Bureau of Animal Industry, in honor of his many contributions to our Knowledge of the Trematoda.

resembles that of *C. pricei* than several of those figured for "Prima" cercariae!

It has already been mentioned that the ducts of the penetration glands are arranged in bundles. They are so closely approximated that anterior to the esophagus there appear to be only two ducts and two apertures on each side. It sometimes happens that one of the posterior pairs of glands, which are situated dorsally, presents the finely granular appearance characteristic of the anterior ventrally situated pairs (see also Sewell, 1922, p. 222). A large spherical nucleus and prominent nucleolus are conspicuous in each penetration gland cell.

Unlike *C. merchanti*, *C. pricei* does not collect on the lighted side of the vessel and in fact shows no phototactic responses whatsoever. At times it manifests a definite tendency to accumulate near the surface. At other times, however, the cerceriae remain distributed at all levels of the water or segregate in the lower levels. It seems probable that the nature of their geotropic response is correlated with temperature changes as suggested by Krull (1931) for cercariae of *P. medioplexus* and *P. parviplexus*. *C. pricei* swims continuously from the time of emergence, with occasional momentary pauses when the body is suddenly extended horizontally. There is also a slight tendency to swarm around small objects in the water, particularly the snail host, but this again seems to depend on certain unknown factors, as it is manifested on some days and not on others.

One very peculiar habit is typical of this cercaria. A fairly large number were kept in glass tumblers, and while swimming they quite frequently came into contact with the sides of the vessel. They then attached themselves and crawled about on the glass by the usual "leeching" movements. At death they did not drop off and fall to the bottom of the container but became fully extended and remained flattened against the glass like a series of permanent preparations. Water beetles, dragonfly nymphs, and other insect larvae were fished from the same pond and introduced into the jars with the cercariae, but penetration was not observed.

EFFECT ON THE SNAIL HOST

The effect of trematode parasites on the ultimate size and growth rate of the molluscan host and the shape of its shell is probably far more universal than is generally recognized. Kelly (1899) apparently first drew attention to this phenomenon in the United States when he recorded change of shell shape in Unionidae due to castration by *Bucephalus* cercariae. He writes:

> From the shape of the shells eight of these thirty-one individuals (infected with cercariae) were pronounced males and two females. Others, also belonging to species in which the shells of the two sexes are normally characteristic, had shells of such shape as to render the sex problematical and to suggest that infestation by *Bucephalus* or other cercariae, when early acquired and

long continued, may so alter the form of the shell of the female as to cause it to resemble that of the male or, if acquired later, may produce an intermediate form.

Rankin (1939) found slight abnormalities of the shell of *Pseudosuccinea columella* infected with echinostome cercariae, but "little or no effect on the snail host from infection with Xiphidiocercariae was observed."

The snails harboring *C. pricei* n. sp. were collected from a tiny isolated pond about 4 by 3 feet, the surface of which was entirely covered with vegetation. A certain number of relatively large specimens of *P. columella* were found resting on the upper side of waterlily leaves, exposed to direct sunshine even during the hottest period of the day (100° F. in the shade). All these proved to be infected with Xiphidiocercariae. No uninfected snails were found in this unprotected situation; there was thus a marked difference in the behavior of parasitized snails.

It is believed that all the mollusks[6] present in this pond were collected and examined. Only those that could have passed through a fine-mesh sieve might have escaped notice. The mean height of uninfected *P. columella* was 3 mm, the maximum size being 4 mm. Infected specimens reached 10 mm in height, with a mean of 9.75 mm. It is not suggested that parasitism is responsible for this great contrast in size, but it might well prove a contributing factor. Without a fairly prolonged study of the snail population of any given area it would be impossible to come to any definite conclusion on this point.

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PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

THE ACADEMY

361ST MEETING OF THE BOARD OF MANAGERS

The 361st meeting of the Board of Managers was held at the Cosmos Club on Friday, May 24, 1940. There were 20 present as follows:

E. C. Crittenden	A. T. McPherson	E. W. Price
F. D. Rossini	A. Wetmore	R. R. Spencer
F. C. Kracek	C. Thom	C. L. Garner
H. S. Rappleye	W. A. Dayton	C. L. Gazin
J. H. Hibben	P. C. Whitney	W. W. Diehl
G. Steiner	H. L. Curtis	and by invitation
F. M. Setzler	W. Ramberg	J. H. Kempton

Acting upon instructions from the Board, President Crittenden appointed the following committees:

(1) To consider societies qualified for affiliation with the Academy: F. M. Setzler, chairman; R. E. Gibson and R. R. Spencer, members.

(2) On awards for scientific achievement: A. H. CLARK, general chairman; Physical Sciences, O. R. WULF, chairman; Engineering Sciences, F. M. DEFANDORF, chairman; Biological Sciences, A. H. CLARK, chairman. The other members of these committees are to be appointed later.

(3) To conserve the archives of the Academy: N. R. SMITH, chairman; F. D. ROSSINI, member.

The following persons, whose names were presented to the Board by the Committee on Membership, were elected to membership:

Resident Members

OLAF SVERRE AAMODT, principal agronomist, in charge of the Division of Forage Crops and Diseases, U. S. Bureau of Plant Industry, in recognition of his work on cereal pathology, particularly with respect to breeding for disease resistance, and also of his studies on forage grasses and legumes.

JAMES KENNETH ABLEITER, senior soil technologist, Division of Soil Survey, U. S. Bureau of Plant Industry, in recognition of his work in land-use planning and in productivity ratings of mineral soils.

CHARLES WALTER BACON, physiologist, Division of Tobacco and Plant Nutrition, U. S. Bureau of Plant Industry, in recognition of his contributions to various aspects of the physiology of tobacco plants, nutrition, etc.

MARK BALDWIN, senior soil scientist, Division of Soil Survey, U. S. Bureau of Plant Industry, in recognition of his outstanding work on the genesis and classification of soils and on the coordination of federal and state soil surveys.

EDWARD EASTMAN CLAYTON, senior physiologist, Division of Tobacco and Plant Nutrition, U. S. Bureau of Plant Industry, in recognition of his contributions on the diseases of tobacco and other plants.

PAUL SYDNEY CONGER, research associate, Carnegie Institution of Washington, and custodian of diatoms, U. S. National Museum, in recognition of his studies on diatoms and their economic use and his discovery of important commercial deposits of diatoms in Wisconsin.

HENRY TRENDLEY DEAN, dental surgeon, Division of Infectious Diseases, National Institute of Health, in recognition of his work on the relationship of fluorine to dental caries.

SAMUEL LEONARD EMSWELLER, principal horticulturist, in charge of Floriculture and Ornamental Horticulture Plant Investigations, Division of Fruit and Vegetable Crops and Diseases, U. S. Bureau of Plant Industry, in recognition of his contributions to horticulture and the cytology and genetics of ornamental plants.

EARL STEINFORD JOHNSTON, assistant director, Division of Radiation and Organisms, Smithsonian Institution, in recognition of his studies on radiation in connection with plant life.

CHARLES EDWIN KELLOGG, principal soil scientist and chief of the Division of Soil Survey, U. S. Bureau of Plant Industry, in recognition of his work on the genesis and classification of soils and on rural land-use planning.

CONSTANTIN NIKIFOROFF, soil scientist, Division of Soil Survey, U. S. Bureau of Plant Industry, in recognition of his work on dynamic processes in soils, on frozen soils of Siberia, on desert types of soil formation, and on the great soil zones of western North America.

GLENN LANE PARKER, chief hydraulic engineer and chief of the Water Resources Branch, U. S. Geological Survey, in recognition of his work in hydrology, particularly on water power and snow surveys in the Cascades and on water resources as related to placer mining.

EUGENE ALFRED SIEGLER, pathologist, Division of Fruit and Vegetable Crops and Diseases, U. S. Bureau of Plant Industry, in recognition of his contributions to phytopathology, particularly his researches on crown gall.

JAMES THORP, soil scientist, Division of Soil Survey, U. S. Bureau of Plant Industry, in recognition of his work on the study and classification of the soils of China.

JACOB OSBORN WARE, senior agronomist, Division of Cotton and other Fiber Crops and Diseases, U. S. Bureau of Plant Industry, in recognition of his work in cotton breeding and genetics and his contributions to agronomy.

Nonresident Members

EUBANKS CARSNER, senior pathologist, Division of Sugar Plant Investigations, U. S. Bureau of Plant Industry, Riverside, Calif., in recognition of his work in the field of virus diseases in plants.

JOHN NATHANIEL COUCH, professor of botany, University of North Carolina, Chapel Hill, N. C., in recognition of his contributions to mycology, particularly on the genus *Septobasidium*.

GORDON ENOCH GATES, professor of biology and head of the Department of Biology, Judson College, Rangoon, Burma, India, in recognition of his special researches on terrestrial oligochaetes.

MOSES BEN NAPHTALI LEVINE, pathologist, Cereal Disease Investigations, U. S. Bureau of Plant Industry, University Farm, St. Paul, Minn., in recognition of his work on cereal rusts and smuts, on physiologic specialization and generic nature of rust pathogenes, and on environment and predisposition of grain crops.

MAURICE BLOOD LINFORD, pathologist, Experiment Station, Pineapple Producers Cooperative Association, Honolulu, Hawaii, in recognition of his work in plant pathology, especially his studies on diseases of peas and pineapples, on plant-parasitic nematodes, on nematode biology and populations, and on natural enemies of nematodes.

ARTHUR SPERRY PEARSE, professor of zoology, Duke University, Durham, N. C., in recognition of his researches in zoology and ecology.

LOWELL FITZ RANDOLPH, chief in research, New York Experiment Station, Geneva, N. Y., in recognition of his work in cytology of chlorophyll types in maize, morphology of developing kernel in maize, chromosomes in maize and related genera, and induced polyploidy in maize and other plants.

WILLIAM JACOB ROBBINS, director, New York Botanic Garden, and professor of botany, Columbia University, New York, N. Y., in recognition of his work on plant nutrition, on enzyme secretion by fungi, on tissue culture with higher plants, and on growth substances.

ELVIN CHARLES STAKMAN, professor of plant pathology, University of Minnesota, and agent of the U. S. Department of Agriculture, University Farm, St. Paul, Minn., in recognition of his contributions to phytopathology particularly on rust diseases of cereals.

JAMES ZETEK, associate entomologist, U. S. Bureau of Entomology and Plant Quarantine, and director, Barro Colorado Island Biological Laboratory, Institute for Research in Tropical America, Balboa, Canal Zone, in recognition of his researches in entomology, his services as a consultant in entomology to certain Latin-American republics, and his management of the Barro Colorado Island Laboratory.

PERCY WHITE ZIMMERMAN, plant physiologist, Boyce Thompson Institute for Plant Research, Yonkers, N. Y., in recognition of his work in plant physiology.

The Committee on Revision of the Bylaws, H. L. CURTIS, chairman, C. THOM and P. C. WHITNEY, members, recommended the following statement on the ballot to be issued on the restoration of the offices of nonresident vice-presidents:

In December 1939 the Academy adopted certain amendments to its bylaws, one group of which had for its purpose the elimination of the two nonresident vice-presidents of the Academy. The section of the bylaws dealing with amendments provides that any three members of the Academy can propose an amendment and that the Board of Managers shall submit this proposal to the members before the next annual meeting. The Board received a petition on January 17, 1940, signed by six members, proposing changes to the newly adopted bylaws, the purpose of which is to restore the two non-resident vice-presidents. Petitioners claim that the provision of two nonresident vice-presidents as members of the Board of Managers is a proper representation of the nonresident members of the Academy. As required by the bylaws, the Board of Managers submits the following to the Academy for action:

Amend Article 2, Section 1, by inserting in the fourth line, "and two vice-presidents chosen from nonresident members." Article 2, Section 3, insert "resident" before vice-president in the fifth line. Article 5, Section 1, insert in the fifth line after the word president "two persons for the nonresident vice-presidents."

In favor of amendment _____

Opposed to amendment _____

To be valid, all ballots must be received by the Secretary within two weeks from date at which they were mailed.

It was moved and carried that this proposed amendment, with the preceding statement of explanation, be submitted for balloting by letter to the members of the Academy at the time of the distribution of the notices for the next regular meeting of the Academy.

The Corresponding Secretary announced the following deaths:

CYRUS ADLER
THOMAS A. GROOVER

The Board adjourned at 9:42 P.M.

BOTANICAL SOCIETY

295TH MEETING

The 295th regular meeting was held in the assembly hall of the Cosmos Club, February 7, 1939, President CHARLES THOM presiding; attendance 95. K. D. DOAK, HAIG DERMEN, and DANIEL READY were elected to membership.

Notes and reviews.—M. B. WAITE called attention to the winter injury that had occurred on the bamboos growing near the Henderson castle and also on Japanese honeysuckle. He believed this was due to the weather at Thanksgiving time when, after a heavy rain, the temperature fell to 17° followed by snow and sleet. He also displayed a very old book, Twaite's *Early western travels*, vol. 3, 1748–1846, which contains "The Travels of André Michaux."

Program.—G. F. GRAVATT: *Effect of epidemic tree diseases on the food supplies of animals* (lantern).—Chestnut blight, *Phytophthora* root rot of *Castanea* species, *Cephalosporium* wilt of persimmon, a nectria disease of beech, and willow diseases, which threaten American forests and woodlands, are

examples of rapidly spreading, supposedly introduced diseases that reduce materially food supplies of wildlife. Diseases reducing winter foods are most serious. One minor objective of the chestnut breeding and selection program is a strain combining small nuts, productiveness, and resistance to blight, which has destroyed nearly all commercial chestnut growth. Species that replace those killed may supply considerably less wildlife food. Even though white-pine seeds are not of outstanding value as wildlife food, the introduced white-pine blister rust has changed the food habits of some wildlife. When food is scarce some animals eat the young blister rust cankers; and other wildlife probably find species replacing *Ribes* eradicated to protect white pines no less valuable as sources of summer food. Diseases that do not kill whole trees may also decrease the food supply of wildlife. Probably our forests have so far been exposed to relatively few of the tree-disease organisms of other continents.

Father ARTHENE DU TILLY: *Botanical exploration in the Canadian Arctics* (lantern).—Father DU TILLY paid a tribute of admiration and gratitude to his predecessors in the exploration and conquest of the Arctic. Touching rapidly on the habitat of the Eskimos, he gave more consideration to the Arctic flora, showing its supreme importance in the life of men and animals, since both live mainly on plants. He compared this vegetation to that of the deserts and explained their physiognomic differences by conditions incident to sunlight, water, wind and snow. He told of the edible roots and berries, the medicinal properties of the greens, the different lichens used as fuel or food and fodder for animals; also of plants which by their variety and richness of coloring adorn the Boreal world. In concluding, Father DU TILLY expressed the wish that more scientists may continue in the footsteps of those pioneers in the discovery of the treasures of the polar regions.

296TH MEETING

The 296th regular meeting was held in the assembly hall of the Cosmos Club, March 7, 1939, President CHARLES THOM presiding; attendance 90. FRED A. ABEGG, CARL O. GRASSL, R. A. STEINGBERG, and JOSEPHINE ROSS were elected to membership.

Notes and reviews.—M. B. WAITE showed some specimens of a rare moss, *Buxbaumia aphylla*, which he and A. V. SMITH collected on his farm near the Patuxent River in Maryland.

Program—DOROTHY BLAISDELL: *Variability studies in the tomato* Fusarium *wilt organism; cultural studies.*—Thirty geographical strains of *Fusarium bulbigenum* var. *lycopersici* were collected from widely separate regions of the United States. These were grown on many different types of solid, liquid and tissue media to determine range of variability, and constancy of cultural characters. The largest number of isolates were divided into two main cultural types: the white, raised sclerotoid forms (RS), and the vinaceous purple, slimy, appressed form (A). Types intervening between these occurred: a group with dark undermats covered with coarse water-soaked mycelium of intermediate raised appearance (IR), and an intermediate appressed group with dark undermats having light fibrilous aerial growth (IA). A raised type was also found (R) similar to RS but without sclerotia and of more stable character. The raised and appressed strains could easily be distinguished on all types of media.

Sectors often appeared in the RS forms. Transfers from these yielded the appressed, slimy forms or intermediate types. Single sporing of the raised sclerotoid forms also yielded both appressed and raised types.

F. L. WELLMAN: *Variability studies in the tomato* Fusarium *wilt organism; pathogenicity studies* (lantern).—Studies of 30 tomato wilt *Fusarium* isolates obtained from diverse regions of the United States showed all, except one, to be *Fusarium bulbigenum* var. *lycopersici*. These cultures were readily separable on the basis of growth appearances into five types, which were found to be correlated with pathogenicity variations observed on tomato varieties susceptible, tolerant, and resistant to *Fusarium* wilt.

Cultures with raised (R) light-colored mycelium were most virulent; raised types with sclerotial-like bodies (RS) were erratic but next in pathogenicity; intermediate raised (IR) types were somewhat lower in pathogenicity; intermediate appressed (IA) were next to the least pathogenic type; and the dark colored completely appressed (A) cultures with no aerial mycelium were the least effective pathogenically. Data from infection studies on the three tomato varieties showed marked divergences in intensity of pathogenic effects due to differences in relative disease resistance.

C. O. ERLANSON: *The first South American Meeting of Botanists, October 12–19, 1938.*

ERNST J. SCHREINER: *Forest tree breeding* (lantern).

297TH MEETING

The annual banquet and 297th meeting of the Botanical Society was held in the Italian Garden of the Mayflower Hotel, April 4, 1939; attendance 125.

Program.—IRA N. GABRIELSON: *Western American alpine plants* (lantern).—A discussion of personal experiences in seeking out and photographing alpine plants in many western mountain areas. The Olympics, Siskiyous, Cascades, Blue Mountains, and several desert ranges in southeastern Oregon were the principal areas visited. It is necessary to make many seasonal trips into each area in order to find the flowers at their best. General floras at or near timberline are strikingly similar, but in many ranges distinct and often beautiful forms and species have been developed. The Siskiyous and Olympics are particularly rich in localized species.

298TH MEETING

The 298th regular meeting was held in the assembly hall of the Cosmos Club, May 2, 1939, President CHARLES THOM presiding; attendance 110.

Notes and reviews.—JOHN A. STEVENSON called attention to his observation of squirrels cutting off elm leaves and twigs at the rate of 4 a minute. They were also cutting off seed pods.

M. B. WAITE displayed a moss protonema that he had found growing in abundance on ground in which potatoes had grown. The ground had been bare in November and now was covered with this moss protonema.

Program.—W. A. ARCHER: *Indian medicinal plants in Nevada.*

H. L. CRANE: *Tung-oil industry in the South.*

JOINT MEETING

A joint meeting of the Botanical Society and the Biological Society was held in the assembly hall of the Cosmos Club, April 14, 1939, President CHARLES THOM presiding; attendance 200.

Program.—LOIS JOTTER: *A botanical trip down the Colorado River by boat from Greenriver, Utah, through the Grand Canyon, to Boulder City, Nevada, August 1938.*

SPECIAL MEETING

A special meeting was held in the assembly hall of the Cosmos Club, September 26, 1939, President CHARLES THOM presiding; attendance 110.

Program.—A. H. REGINALD BULLER: *The sexual process in the rust fungi* (lantern and models).—In long-cycled heteroecious heterothallic rust fungi, *e.g., Puccinia graminis*, the sexual process may be initiated in two different ways: (1) In compound pustules where a (+) mycelium derived from a (+) basidiospore has fused with a (−) mycelium derived from a (−) basidiospore, by an exchange of nuclei, (+) nuclei traveling through the (−) mycelium to the (−) proto-aecidia and (−) nuclei traveling through the (+) mycelium to the (+) proto-aecidia; and (2) where (+) and (−) pustules are widely separated from one another so that compound pustules cannot be formed, by insects conveying (+) pycnidiospores from (+) pustules to (−) pustules and (−) pycnidiospores from (−) pustules to (+) pustules, then by (+) pycnidiospores fusing with (−) flexuous hyphae and (−) pycnidiospores fusing with (+) flexuous hyphae and, finally, by the nuclei of the pycnidiospores traveling down flexuous hyphae to the proto-aecidia. Flexuous hyphae are special hyphae projecting beyond the periphyses into the drop of nectar that is exuded from the ostiole of every active pycnidium.

299TH MEETING

The 299th regular meeting was held in the assembly hall of the Cosmos Club, October 3, 1939, President CHARLES THOM presiding; attendance 100. OLAF S. AAOMDT was elected to membership.

Notes and reviews.—M. B. WAITE exhibited a moss, *Webera sessilis*, which he found growing near Patuxent, Md. It does not have any stem and is about one-fifth the size of a kernel of wheat and is commonly called "powder gun." He also displayed a plant, *Oldlandia uniflora*, which he found growing at the Horticultural Station at Beltsville, Md. It is related to the common spring bluet. He also called attention to a Bartram's oak (*Quercus heterofilia*), which is growing at Twelfth and C Streets, SW., Washington, D. C. J. B. S. NORTON stated there was a Bartram's oak on the Boulevard near Riverdale, Md.

Program.—S. F. BLAKE: *Early American botanists, John Bannister (1650–1692), John Clayton (1686–1773), Humphrey Marshall (1722–1801).*—John Bannister, born in England, visited the West Indies and settled in Virginia in 1678. He collected plants and animals and published several papers on these subjects. His most important botanical work is his list of about 147 Virginia plants, published in Ray's *Historia plantarum* in 1698. John Clayton, born in England came to Virginia in 1705 and was assistant clerk and clerk of Gloster County for over 50 years. His extensive botanical collection from Tidewater Virginia were the foundation of Gronovius's *Flora Virginica* (1739–1743), the most important single basis for North American species in Linnaeus's *Species plantarum*. Humphrey Marshall, a cousin of John Bartram, was born and lived all his life in eastern Pennsylvania. He established a private botanical garden, and published his *Arbustrum Americanum* in 1785. This was the first work on United States botany published in the United States.

M. THOMAS BARTRAM: *An early American botanist, John Bartram 1699–1777.*—John Bartram, grandson of a colonist under William Penn, can best be described as a plain farmer possessing only a country school education supplemented by wide reading in physics and medicine. His interest in botany was acquired while still in his twenties, and his knowledge of the

subject was self-taught through extensive correspondence with American and European botanists, and the reading of the contributions of Linnaeus and others. His garden of native plants and shrubs, started in 1731 and in existence today, is recorded as the earliest in America and served as a source for the shipment of all types of botanical specimens to subscribers in Europe. The revenue derived from this activity supported extensive explorations from "New England to Florida; and from the sea coast to Lake Ontario and branches of the Ohio." In 1765 he was appointed "Botanist to the King" and commissioned to explore Florida and the St. John River.

ROBERT F. MARTIN: *An early American botanist, Thomas Walter 1740?–1789.*

300TH MEETING

The 300th regular meeting preceded by an informal dinner at Hogate's Restaurant, was held at the restaurant, 8:30 P.M., November 7, 1939; attendance 150.

Notes and reviews.—M. B. WAITE as master of ceremonies briefly reminisced about the early botanists of the society as their pictures were shown on the screen.

Program.—C. STUART GAGER: *How botany advances.*—This address stressed the importance for the advancement of botany, and of science in general, of strict adherence to the scientific method, and illustrated the errors and the absurdities into which students of plant life have been led by failure to employ what is now generally recognized as "the method of science." These illustrations were drawn from the writings of Aristotle (384–322 B. C.), Caesalpino (1583), Oken, the "physio-philosopher" (1809), Nicolaus of Cusa (1514), Van Helmont (1648), Gerard (1597), Parkinson (1640), and others.

In addition to the more commonly recognized steps of scientific method (observation, experiment, the formulation and testing of hypotheses), the the speaker emphasized the importance of another factor less often stressed, namely, what has been called the "divination" or "revelation" of the solution of scientific problems, which Lord Kelvin described as characterizing his own process. The contrast was also noted between Darwin's statement of his procedure, from facts to concept (natural selection), and de Vries's statement of his procedure, namely, from concept (intracellular pangenesis) to observation of facts and finally the formulation of the generalization of mutation. ALICE M. ANDERSEN, *Recording Secretary.*

Obituary

THOMAS ALLEN GROOVER, physician and radiologist, died on April 20, 1940, from x-ray injuries dating from the early days of his investigations.

Dr. Groover was born at Pidcock in southern Georgia on May 1, 1877, a son of Thomas Alfred and Sarah Jane (Joiner) Groover. His father, a farmer, was a Confederate soldier during the Civil War and had lost an arm in action. Dr. Groover received his early education in the public schools of Brooks County, Ga. Because of financial considerations it did not seem possible for him to continue his education, but through the good offices of the Hon. Hoke Smith, of Georgia, Secretary of the Interior in President Cleveland's Cabinet, he was appointed assistant messenger in the Department of the Interior. He came to Washington in 1893 and resided here the remainder of his life. In 1894 he entered the Medical Department of Columbian University, later George Washington University, and graduated in

1898. In 1926 his alma mater conferred upon him the degree of doctor of science. After internship at the Garfield Memorial Hospital he was appointed physician with the Isthmian Canal Commission and in that capacity spent the next year in Nicaragua.

He returned to Washington in 1900 and entered the general practice of medicine. At the same time he began x-ray work at the Central Dispensary and Emergency Hospital. Although he did not completely specialize in radiology until 1912, he was actively engaged in that field from 1900 up to within three months of his death. It was in those early days from 1900 to about 1904 or 1905 that he suffered the injuries to his hands that resulted in amputation through the left forearm in 1926 and to final involvement of the right axilla and lung, which cost him his life.

Dr. Groover was closely associated with the scientific progress and the organizational development of radiology in this country. He made numerous contributions to the literature and was always interested and quietly helpful in everything that affected the welfare of the specialty he loved. He was insistent, however, that the radiologist is primarily a physician, and as such he always established a personal relationship with every patient who came under his care.

Dr. Groover's work as a practicing radiologist was characterized by the utmost painstaking care and attention to detail. He not only required the best possible technical work but spared no time or personal effort to arrive at a correct interpretation and final diagnosis. He had developed in himself to a very high degree those qualities that are indispensable in the good physician, accuracy in observation and a keen sense of relative values. He was a diagnostician of unusual ability. In manner Dr. Groover was quiet and reserved. Being of a very studious habit, he made it a rule to spend at least one hour a day in reading medical literature. He had great qualities both of mind and heart that were unusual and outstanding. His ability as an organizer and executive was recognized. His careful, methodical attention to all the details of bookkeeping, records, and management laid the foundation for his professional work. He always looked upon business arrangements, however, as a means to more important ends. He was first and last a physician. Even radiology, in every branch of which he was proficient, he insisted must always be looked upon as an integral part of general medical practice. His outstanding mental characteristics were patience and a great capacity for methodical, painstaking care in every diagnostic and therapeutic procedure. His dominant moral characteristic was a keen sense of justice, right, and fair dealing. He had an unfailing patience in compromising differences of opinion among his associates, a sane judgment in arriving at important decisions, and above all, a kindly, tolerant charity toward all with whom he could not agree. He will be greatly missed by his close associates who were accustomed to call upon him almost daily for his helpful counsel, and his loss will be keenly felt in many organizations in which his advice was highly valued. His death adds another martyr to the long roll of those who have sacrificed their lives in the interests of science and humanity.

Dr. Groover was a member of the following organizations: The Washington Academy of Sciences (vice-president, 1925); the Medical Society of the District of Columbia (president, 1925); the American Medical Association (fellow); the American College of Physicians (fellow); the Southern Medical Association (vice-president, 1924); the American Roentgen Ray Society (president, 1925); the Radiological Society of North America; and the American College of Radiology (fellow), in which he served both as president and as chancellor.